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Issued May 1961

SOIL SURVEY

Sanilac County Michigan

OUR SOIL ★ OUR STRENGTH

Growth Through Agricultural Progress

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
MICHIGAN AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

A person who has lived in a locality for a long time probably knows the major differences among the soils of that area. He may not, however, know how nearly these soils are like the soils on experimental fields or in other parts of the county where higher yields are reported. He may wonder whether those higher yields are from soils like his own or from soils so different that he could not expect similar yields. If he knows the kinds of soil on his farm and compares them with soils on which new methods have been tried, he can avoid some of the risks in trying new management practices or new crop varieties.

Farmers and those who work with farmers can use this report most conveniently by following this procedure:

1. Locate the farm on the index map at the back of this report. Numbered rectangles on the index map show the area covered by each sheet of the soil map. Each sheet of the soil map of Sanilac County shows an area of 4 square miles.
2. Outline on the soil map the land in which you are interested. This can be done by finding the township, section, and part of the section in which the tract is located. Landmarks such as roads, streams, villages, schools, churches, houses, and other features will be helpful. The legal land description of your farm will also be helpful. This description is in the abstract of your title and is on your annual tax receipt.
3. Know the soils in each field on your farm. Each kind of soil is shown by a symbol on the soil map. A map symbol consists of three parts. The first capital and small letter together stand for the soil series and the texture of the plow layer; the next capital letter shows the range of slope; and the final number designates the degree of erosion. For example, the symbol MfB1 stands for Marlette loam, 2 to 6 percent slopes, slightly eroded. The derivation of the map symbols is described in detail in the section, Descriptions of Soils.

The soils on your farm, or in the land in which you are interested, are described in alphabetical order in the section, Descriptions of Soils. A map symbol precedes the name of each soil, or mapping unit. With the aid of the soil descriptions and the soil map, you usually will be able to identify the soils in each field.

4. Find detailed suggestions for management of your soils in the section, Use and Management of Soils. If you are looking at the map and want to know the management unit a soil is in, turn to table 7, p 43. This table gives the map symbol for each soil, the management unit, and the page on which the management unit is described. If you are reading in the section that describes the soils, you will notice that the soil management unit is given for each soil or mapping unit. Thus you can note the soil management unit symbol for a soil, turn to table 7, and read from that table the page on which the soil management unit containing this soil is discussed. It is not sufficient to read only about the management unit. Read also the discussion for the soil management group in which this unit has been placed. Further information about management may be obtained from representatives of the Soil Conservation Service or the Cooperative Extension Service in Sanilac County, or from the Soil Science Department at Michigan State University, East Lansing, Mich.

Soil scientists will find information about how the soils are formed and how they are classified in the section, Morphology and Genesis of Soils.

Engineers will find information pertaining to their work and references to other information in the section, Engineering Applications.

Students, teachers, and other users will find information about the soils and their management in various parts of the report, depending on their particular interest. Those interested in broad soil areas in Sanilac County should read the section, Soil Associations, and examine the general soil map at the back of this report. A Glossary is provided for those not familiar with the technical terms used or who want to know the special meaning that some common terms have in soil science.

In making this survey, soil scientists walked over the fields and woodlands. They dug holes and examined the surface layer, subsoil, and substratum; measured slopes with an Abney level; noticed differences in the growth of crops, weeds, and trees; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming, engineering, forestry, and related uses. The scientists plotted the boundaries between the soils on aerial photographs in the field. Then cartographers prepared the detailed soil map in the back of the report from those field sheets.

Fieldwork was completed in 1953. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time.

Help in farm planning can be obtained from the Soil Conservation Service or the Cooperative Extension Service in the county or from the Soil Science Department, Michigan State University, East Lansing, Michigan.

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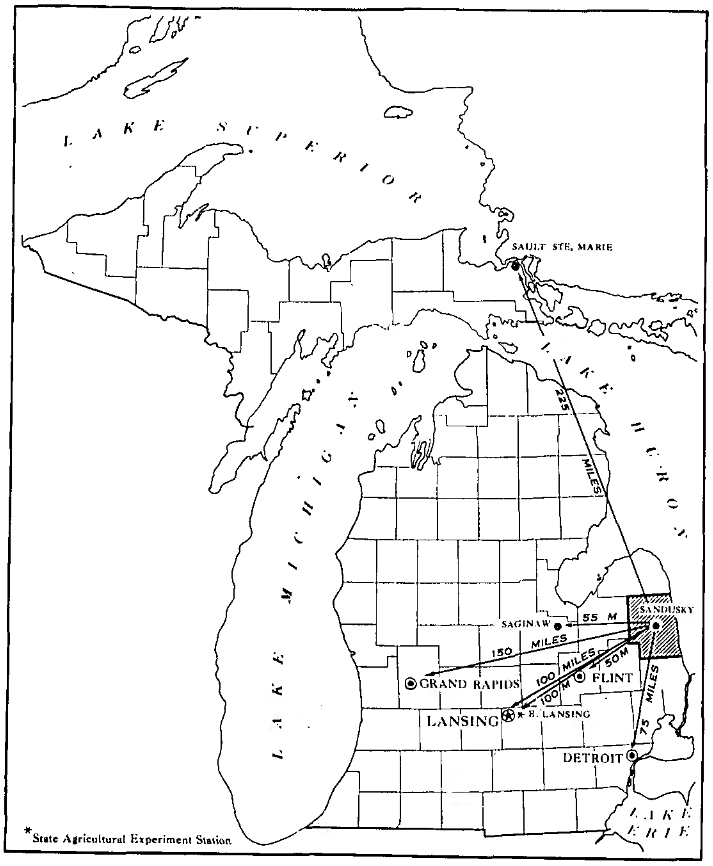

Figure 1.—**Location of Sanilac County in Michigan.**

SANILAC COUNTY is in the eastern part of the Lower Peninsula of Michigan, bordering Lake Huron (fig. 1). It is about 36 miles from north to south and about 30 miles from east to west. The total area is about 615,000 acres, or about 960 square miles. Sandusky is the county seat. In 1950, nearly 31,000 people lived in Sanilac County. The climate is favorable for the growth of most crops of the area, and agriculture is the principal industry. Dairy farming is the chief agricultural enterprise. The principal crops are oats, alfalfa, wheat, corn, dry field beans, sugar beets, timothy, and clover.

Soils of Sanilac County

The various kinds of soils in Sanilac County differ from each other mainly because they have developed from different kinds of parent material, under different conditions of drainage, and for different lengths of time. The soils were formed after the glaciers melted some 8,000 to 20,000 years ago and after the processes of soil formation began to alter the glacial debris. Part of the water from rainfall and snowfall has moved downward through the glacial deposits. This movement of water, along with the effect of oxygen and carbon dioxide and the decomposition of vegetation, caused changes in the glacial debris. Layers, or horizons, that differ in physical and chemical composition gradually developed. A vertical section through these layers is called a soil profile. Special Bulletin 402, Soils of Michigan, published by the Michigan State University (*17*)[2] describes some of the kinds of soils in the State and shows colored profiles of some of them.

The soils of the county are of two major kinds, those derived from mineral matter, and those derived from organic matter. The two kinds are discussed separately.

Mineral Soils

In table 1, all the mineral soil series in the county are arranged according to texture of the parent material and the natural drainage. A soil series is a group of soils that formed from a particular kind of parent material. It consists of soils that have layers similar in characteristics, except for the texture of the surface mineral layer, and that are similarly arranged in the soil profile.

[1] Most of the fieldwork was done while the Soil Survey Division was part of the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

[2] Italic numbers in parentheses refer to Literature Cited, p. 82.

TABLE 1.—*Soil series formed on different kinds of mineral parent material under different degrees of natural drainage*

Texture of parent materials	Well drained to moderately well drained soils	Imperfectly drained soils	Poorly to very poorly drained soils
ONE-STORIED PARENT MATERIALS			
Clay loam or silty clay loam:			
High in lime			Thomas.[1]
Moderate in lime	Huron	Perth	
Low in lime			Jeddo.
Loam or silt loam:			
High in lime; not stratified	Guelph	London	Parkhill. Tappan.[1]
Moderate in lime; not stratified	Marlette	Capac	Parkhill. Tappan.[1]
High in lime; stratified	Gagetown [1]	Sanilac [1]	Bach.[1]
Sandy loam:			
Moderate in lime; not stratified	McBride	Coral	Ensley.
Moderate in lime; stratified		Richter	Tonkey.
Loamy sand:			
Low in lime; not stratified	Montcalm	Otisco	Edmore.
Sand: Stratified or not stratified	Rubicon	Au Gres	Roscommon.
	Kalkaska	Saugatuck [2]	Tobico.[1]
	Eastport		
	Croswell		
	Wallace [2]		
TWO-STORIED MATERIALS			
Mineral and organic materials, stratified or mixed			Kerston.
Loam to silt loam overwash on organic soils			Wallkill.
Silt loam to sandy loam overwash on dark-colored mineral materials			Washtenaw.
Sandy loam to sandy clay loam 18 to 42 inches thick over gravel and sand (thick textural B horizons).	Newaygo	Palo. McGregor [1]	Ronald.
Sand to loamy sand 18 to 42 inches thick over sand and gravel (thin textural B horizons).	Mancelona	Gladwin	Epoufette.
Sand to loamy sand 18 to 42 inches thick over loam to silty clay loam (no textural B horizons).	Menominee	Iosco	
Sand to loamy sand 42 to 66 inches thick over loam to clay (no textural B horizons).	Melita	Arenac. Winegars	Roscommon.
Very fine sands and silts 18 to 42 inches thick over loam to silty clay loam (textural B horizons).		Saverine	
Muck 0 to 12 inches thick over marl			Warners.
Loamy sand to sandy loam 18 to 42 inches thick over Marshall sandstone.		Tyre	

[1] Calcareous at or near the surface.

[2] Subsoil cemented with humus and iron oxides.

Well-drained and imperfectly drained soils in Sanilac County differ according to texture of the parent material. Those developed in sand have one kind of subsoil layer, and those that developed in loamy sand to loam have another. In the sand, iron oxides and humus have been concentrated in a subsoil layer that underlies a thin, dark-colored surface layer and leaf litter. Soils of this kind are called Podzols. Phosphate fertilizers may be less effective on Podzols than on other soils. This is because the iron oxides and humus, which may be mixed into the surface layer by plowing, react with soluble phosphate and form insoluble compounds.

In the loamy sand to loam materials, soils were developed that have an upper subsoil layer similar to the subsoil layer that formed in the sand. Under this layer, these soils have a layer enriched by clay that has been washed down from the layer above. This layer is similar to the subsoil layer in soils that are called Gray Wooded soils. The soils formed in loamy sand to loam, therefore, have some characteristics of Podzols and some characteristics of Gray Wooded soils and are called Podzols (intergrading to Gray Wooded soils) (*6*).

Gray Wooded soils also developed in well-drained and imperfectly drained sites in this county. Their parent materials are finer textured than those of the soils that are Podzols and Podzols (intergrading to Gray Wooded soils).

Soils that resemble Podzols in many respects have developed in deep sandy materials where the water table fluctuates within 2 to 4 feet of the surface. They are called Ground-Water Podzols, and they differ from Podzols in that they have a thicker, nearly white subsurface layer and a strongly cemented layer in the subsoil.

The well-drained mineral soils of Sanilac County have a subsoil with fairly uniform colors of brown, red, and yellow that extend to depths of 30 or more inches. The imperfectly drained soils, in contrast, are mottled with splotches of gray, orange, or rust brown in the subsurface layer or in the upper part of the subsoil.

Poorly drained and very poorly drained mineral soils, called Humic Gley soils, have developed in the low areas that generally had a dense swamp forest and a high water table. These areas were not covered by water long enough for organic soils to form. The organic material has been

mixed with the mineral material in the upper part of the profile, and organic mineral layers have developed. These layers are darker colored and thicker than the organic-mineral layers in the upper part of the profile of the better drained Podzols and Gray Wooded soils. Under the organic-mineral layers, the Humic Gley soils are generally solid gray in color or have an olive-gray layer that is normally splotched or streaked with orange, rust brown, or yellow.

The youngest soils in the county lie on the flood plains of the Elk, Black, and Cass Rivers and along most of the smaller streams. These soils are still receiving deposits during spring floods. They are similar to the deposited alluvium because that material has not been in place long enough for the processes of soil formation to alter it appreciably. These young soils are called Alluvial soils. Differences in their natural drainage are indicated by the color of the soils and the amount of organic material present.

Organic Soils

Organic (Bog) soils are widely distributed in Sanilac County and make up about 7 percent of the area. These soils are mucks and peats that were formed under poor or very poor natural drainage. They consist of more than 12 inches of organic matter over mineral materials. Table 2 shows important relationships of the organic soils in Sanilac County.

Soil Associations

In mapping a county or other large tract, definite differences are fairly easy to see as one travels from place to place. There are many obvious differences in shape, gradient, and length of slope; in course, depth, and speed of streams; in the width of natural flood plains; in the kinds of native plants; and even in the kinds of agriculture. With these more obvious differences, less easily noticed differences occur in the patterns of the soils. The soils differ along with the other parts of the environment.

By drawing lines around the different patterns of soils on a small map, one may obtain a map of the general soil areas, or, as they are called in this report, soil associations. Such a generalized map is useful to those who want only a general idea of the soils, or wish to compare different parts of the county, or want to locate large areas suitable for some particular kind of agriculture or other broad land use. The generalized map will be of particular interest to geographers, zoning officials, and those who plan for the use of county land.

The eleven soil associations, or kinds of soil patterns, in Sanilac County are shown in colors on the soil association map at the back of this report. A brief description of each of these associations follows.

Soil Association 1

Soil association 1 has a total area of about 166,300 acres. It consists mainly of nearly level to undulating, poorly to imperfectly drained, dark grayish-brown to black sandy loams to loams that are neutral in reaction. These soils were developed mainly on calcareous sandy loam to loam till. About one-fourth of the acreage consists of sandy deposits, 18 to 66 inches thick, and organic soils of various depths. Also in the association are some dry sands that extend deeper than 66 inches. The principal soils are the Parkhill and Capac soils and some organic soils.

The soils in this association are mainly in crops used to feed dairy cattle and in dry beans, wheat, and sugar beets. If they are adequately drained and properly fertilized, the soils are very productive. The main problems of man-

TABLE 2.—*Relationships of organic (Bog) soils in Sanilac County, Mich.*

Origin	Organic material between depths of 12 to 42 inches	pH at depths of 12 to 42 inches	Organic material more than 42 inches deep	Organic material 12 to 42 inches deep [1]			
				Over sands	Over loams	Over clays	Over marl
Woody:							
Deciduous and coniferous trees.	Black, granular, well-decomposed woody material over undecomposed, brown, fibrous material.	8. 3–7. 0	----------	----------	----------	----------	Edwards.
Deciduous trees	Dark brown, slightly to moderately decomposed material over undecomposed, brown, fibrous material.	7. 0–5. 0	Carlisle	Tawas	Linwood	Willette	
Coniferous and deciduous trees.	Brown to yellow, undecomposed, fibrous material.	6. 5–4. 5	Rifle	Tawas	Linwood	Willette	
Woody and fibrous:							
Conifers and marsh	Brown to yellow, undecomposed, fibrous material.	5. 0–3. 0	Spalding	----------	----------	----------	
Fibrous:							
Leatherleaf bogs	Yellow, undecomposed, fibrous material.	5. 0–3. 0	Greenwood	----------	----------	----------	
Marsh	Dark-brown, yellow, finely fibrous material.	7. 0–5. 0	Houghton	Adrian	Palms	----------	

[1] Shallow organic soils generally have a colloidal or sedimentary peaty layer directly above the underlying mineral materials.

agement are inadequate outlets for tile lines; deficiency in manganese, boron, and other minor elements; and the maintenance of soil structure.

Soil Association 2

Soil association 2 has a total area of about 24,000 acres. It consists mainly of nearly level to rolling, well to poorly drained, medium acid to neutral sandy loams and loams. These soils were developed from sandy loam to loam till that is calcareous at depths of 26 to 44 inches. Poorly drained mineral and organic soils make up 15 to 20 percent of the acreage. The principal soils in the association are the Marlette and Capac soils and some organic soils.

This association is used mainly for dairying and for general farming. Wheat is the main cash crop on many farms. Except in sloping areas, the soils are deep, relatively fertile, and durable under cultivation. These soils respond well to management that provides adequate fertilizer and lime and the control of water erosion.

Soil Association 3

Soil association 3 has a total area of 51,000 acres. It consists mainly of level, very poorly drained, black to dark grayish-brown peats and mucks that are extremely acid to mildly alkaline. These soils have developed from woody and fibrous organic materials. Many areas have been burned over, and the organic accumulation over the mineral material ranges from shallow to very deep. Less than 10 percent of this association consists of mineral soils.

Except for areas of slightly decomposed, extremely acid peats, the adequately drained and fertilized organic soils are used for mint, onions, truck crops, and some field crops. Large areas are used for pasture or remain in second-growth forest. The main soil management problems are maintaining fertility, controlling the height of the water table, and controlling wind erosion. Late spring or early fall frosts are also a hazard.

Soil Association 4

Soil association 4 has a total area of about 93,700 acres. It consists mainly of undulating to hilly, well to imperfectly drained, light-brown to very dark grayish-brown sandy loams to loams that are slightly acid to neutral. These soils were developed from loam and clay loam till that has carbonates at depths of 18 to 26 inches. In moderately or severely eroded areas, the soils are calcareous at or near the surface. The principal soil series are the Guelph and London.

This association is used mainly for dairy farming and for general farming; wheat and dry beans are the main cash crops. The soils are relatively productive and are well suited to alfalfa, corn, small grains, and dry beans. They respond well to management that provides fertilization and the control of water erosion. Water erosion is a problem on cultivated slopes.

Soil Association 5

Soil association 5 has a total area of about 84,500 acres. It consists mainly of nearly level, imperfectly drained to very poorly drained, dark grayish-brown to black loamy sands and clay loams that are medium acid to mildly alkaline. About half of the acreage consists of loamy sand to loam, 18 to 42 inches deep, that overlies loam to silty clay loam materials. There are also dry sands that extend deeper than 42 inches. The London, Iosco, Parkhill, and Saverine are the principal soil series.

The main types of farming are dairy farming and general farming. Wheat and dry beans are the chief cash crops. The soils need to be drained before they are cropped. Because the sandy overburden has a variable thickness within short distances, an adequate drainage system may be difficult to establish. Areas that have a thin surface layer of sandy materials are more suitable for field crops than areas that have a thick surface layer of sandy materials. When adequately drained, the Parkhill and London soils are very productive.

Soil Association 6

This soil association has a total acreage of about 12,200 acres. It consists mainly of level to undulating, well to imperfectly drained sands that are very strongly acid to neutral. In more than half of the area, the sands are underlain, at depths of 42 to 66 inches, by medium- to fine-textured materials. The principal soil series are the Melita, Arenac, Croswell, and Eastport.

This association is used mainly for pasture and second-growth forest. A large acreage of cleared land is no longer cropped. The area along Lake Huron is used for recreation. The soils are low in natural fertility and in water-holding capacity. The cleared areas are susceptible to wind erosion.

Soil Association 7

Soil association 7 has a total area of about 10,700 acres. It consists mainly of level to undulating, imperfectly to very poorly drained, grayish-brown to black sands and sandy loams that are slightly acid to calcareous. The soils have a sandy loam to sandy clay loam subsoil underlain at 24 to 42 inches by stratified, calcareous sands and gravel. The principal soil series are the Palo, Gladwin, and Epoufette.

This association is used mainly for dairy farming. A considerable acreage is in permanent pasture and second-growth forest. Many gravel pits occur. Because of the coarse-textured, stratified materials, installing tile drains is difficult.

Soil Association 8

Soil association 8 has a total area of about 53,200 acres. It consists of undulating to hilly, well-drained soils that have a pale-brown to very dark grayish-brown or black surface and that are strongly to slightly acid. These soils developed from loamy sand, sandy loam, and sand parent material. They have low to moderate water-holding capacity. The main soil series are the Montcalm, McBride, and Rubicon.

This soil association is used largely for dairy farming and general farming. The soils are low to medium in pro-

ductivity. They are low in content of organic matter but are easily tilled and warm up early in spring. Water erosion is a problem on cultivated slopes, and wind erosion control is needed where sandy areas are cropped. The soils respond well to fertilizer and manure.

Soil Association 9

Soil association 9 has a total area of about 63,300 acres. It consists mainly of nearly level to undulating, very poorly drained to imperfectly drained, dark grayish-brown to nearly black loams and clay loams that are neutral and mildly alkaline. These soils were developed from calcareous loam and clay loam till. The part of this association occupied by sandy smears and organic soils is much smaller than in soil association 1. These soils also have more rapid surface drainage than the soils in soil association 1. The principal soil series are the Parkhill and Capac.

This soil association is used for dairy farming and for general farming; dry beans, wheat, and sugar beets are the main cash crops. The soils are very productive where adequately drained and properly fertilized. The principal soil management problems are providing adequate drainage and maintaining tilth.

Soil Association 10

Soil association 10 has a total area of about 43,600 acres. It consists mainly of nearly level to rolling, well to poorly drained, pale-brown to very dark grayish-brown loamy sands to loams that are strongly acid to neutral. Many areas consist of sand, loamy sand, or sandy loam, 18 to 66 inches deep over medium- to fine-textured materials. Organic soils occupy about 10 percent of this association.

This association has a complex pattern of naturally wet and dry soils that have a wide textural range. This complexity lessens the suitability of the soils for crops. In places boulders and stones further reduce value for crops. The coarser textured soils on uplands are poor to fair in water-holding capacity, are fair in natural fertility, and are susceptible to wind and water erosion. These soils respond to good management that provides crop rotations, fertilization, and erosion control practices. If adequately drained, the dark-colored soils in this association are productive.

Soil Association 11

Soil association 11 has a total area of about 12,500 acres. It consists of level to undulating, poorly drained to imperfectly drained, dark grayish-brown to black sandy loams and loams that are slightly acid to neutral. The association occupies old glacial drainageways. Large amounts of stones, cobbles, and boulders are on the surface and throughout the profile.

Most of this association is used for permanent pasture or remains in second-growth forest. Because of the stones and boulders and the difficulty of installing tile drains, this association is used only to limited extent for rotation crops.

Descriptions of Soils [3]

This section provides detailed information about the soils of Sanilac County. For more general information, refer to the section, Soil Associations, which describes the broad patterns of soils in the county.

In this section the soil series is described first, and then, very briefly, the soil types. A soil series is a group of soils that developed from similar parent material and that have, except for texture of the surface layer, similar characteristics. The description of each soil series tells about the general character of the soil series and its relation to other series. A representative soil profile is described in detail for each series. A soil profile is a vertical section showing all the layers, or horizons, from the surface through the parent materials.

The mapping units in a given series have essentially the same characteristics, except texture of the surface layer and external properties, such as slope, stoniness, erosion, that particularly affect management of the soils but do not affect their placement in an orderly natural classification. Hence, for some mapping units that follow the series description, only the name will be given, because the name itself describes external characteristics of the mapping unit. For other mapping units, after a series description, one or two sentences are added to point out distinctive characteristics of the mapping unit.

In the map legend, a symbol precedes the name of each mapping unit. This map symbol consists of letters and a number. The first two letters (a capital letter and a small letter) identify the soil series and the texture of the plow layer. The second capital letter, A, B, C, D, or E, indicates the slope ranges as follows:

A------0 to 2 or 3 percent slopes.
B------2 to 6, 2 to 7, or 2 to 8 percent slopes.
C------6 to 12, 7 to 14, 2 to 18, 8 to 18, or 8 to 15 percent slopes.
D------12 to 18, 15 to 25, or 14+ percent slopes.
E------18 to 25, or 18+ percent slopes.

The last figure in the map symbol is an arabic number, 1, 2, or 3 which stands for erosion classes as follows:

1------Slightly eroded or slightly or moderately eroded.
2------Moderately eroded or slightly to severely eroded.
3------Severely eroded, or moderately or severely eroded.

Following the name of the mapping unit is a symbol that denotes the soil management group or unit in which it has been placed. A management unit is a group of soils that need about the same kind of management and respond to this management in about the same way. Information about the suggested management of a mapping unit can be found by noting the management unit designation and then turning to the subsection, Management by Groups and Units.

The location and distribution of the mapping units can be seen by referring to the soil map at the back of this report. The approximate acreage and proportionate extent of the mapping units are given in table 3.

The descriptions of the soil series are somewhat technical. A number of technical terms are defined in the glossary at the back of the report, as well as some general terms that have special meaning in soil science. The lay

[3] This section was written by IVAN F. SCHNEIDER, Michigan State University, and H. H. BAILEY, Soil Conservation Service.

reader may have some difficulty with the soil profile descriptions. For this reason some terminology used by soil scientists is defined in the glossary and discussed in the following paragraphs.

In describing soils, the soil scientist assigns a letter symbol and subscript, for example, "A_p", to the various layers or horizons of the soil profile. These letter symbols have a special meaning that concerns scientists and others who desire a special study of the soils. Most readers will only need to remember that all letter symbols beginning with "A" are surface or subsurface layers; those beginning with "B" are subsoil layers; those beginning with "C" are substratum or parent material; and those beginning with "D" are underlying, dissimilar materials.

Texture refers to the amounts of sand, silt, and clay that make up the soil material. The different textural classes are defined in Special Bulletin 402 published by the Soil Science Department, Michigan State University (*17*). The texture of the materials in the various horizons of the soil profile is given.

Color is denoted in two ways, by a descriptive term and by a Munsell notation. The descriptive term, for example, "grayish brown," is followed by a Munsell notation, such as "(10YR 5/2)". Munsell notations denote color with a great deal more precision than is possible by use of words. Unless otherwise stated, the color given is the color of the soil material when moist.

The consistence of the material in each horizon is significant. Consistence denotes the feel of soil material when it is rubbed between the fingers. Consistence can be determined when the soil is wet, moist, or dry. Terms commonly used to describe consistence are "plastic when wet," "friable when moist," and "hard when dry."

TABLE 3.—*Approximate acreage and proportionate extent of the soils mapped*

Mapping unit	Area	Extent
	Acres	*Percent*
Adrian muck, 0 to 2 percent slopes	238	(1)
Alluvial land, poorly drained loams, 0 to 2 percent slopes	5, 423	0. 9
Alluvial land, poorly drained loams, 2 to 6 percent slopes	52	(1)
Alluvial land, imperfectly or moderately well drained sandy loams, 0 to 2 percent slopes	4, 951	. 8
Alluvial land, imperfectly or moderately well drained sandy loams, 2 to 6 percent slopes	554	. 1
Alluvial land, poorly drained sandy loams, 0 to 2 percent slopes	3, 143	. 5
Alluvial land, poorly drained sandy loams, 2 to 6 percent slopes	66	(1)
Au Gres and Saugatuck loamy sands, 0 to 2 percent slopes	810	. 1
Au Gres and Saugatuck loamy sands, 2 to 6 percent slopes, slightly eroded	116	(1)
Bach silt loam, 0 to 2 percent slopes	229	(1)
Capac loam and fine sandy loam, 0 to 2 percent slopes	37, 150	6. 0
Capac loam and fine sandy loam, 2 to 6 percent slopes, slightly eroded	7, 201	1. 2
Capac loam and fine sandy loam, 6 to 12 percent slopes, moderately eroded	27	(1)
Capac silt loam and loam, 0 to 2 percent slopes	36, 534	5. 9
Capac silt loam and loam, 2 to 6 percent slopes, slightly eroded	2, 786	. 5
Capac silt loam and loam, 2 to 6 percent slopes, moderately eroded	181	(1)
Carlisle muck, 0 to 2 percent slopes	762	. 1
Carlisle and Linwood mucks, 0 to 2 percent slopes	6, 556	1. 1
Clay pit	5	(1)
Coral fine sandy loam, 0 to 2 percent slopes	4, 217	. 7
Coral fine sandy loam, 2 to 6 percent slopes, slightly eroded	5, 804	. 9
Croswell loamy sand, 0 to 2 percent slopes, slightly eroded	595	. 1
Croswell loamy sand, 2 to 7 percent slopes, slightly eroded	536	. 1
Eastport, Arenac, and Kalkaska sands, 0 to 2 percent slopes, slightly eroded	237	(1)
Eastport, Arenac, and Kalkaska sands, 2 to 7 percent slopes, slightly eroded	348	. 1
Eastport, Arenac, and Kalkaska sands, 7 to 14 percent slopes, slightly eroded	97	(1)
Eastport fine sand and Beach sand, 0 to 2 percent slopes	166	(1)
Eastport fine sand and Beach sand, 2 to 18 percent slopes	137	(1)
Edmore and Ensley sandy loams, 0 to 2 percent slopes	4, 918	0. 8
Edmore and Ensley sandy loams, 2 to 6 percent slopes, slightly eroded	34	(1)
Edwards muck, 0 to 2 percent slopes	845	
Epoufette and Ronald sandy loams, 0 to 2 percent slopes	1, 938	. 3
Epoufette and Ronald sandy loams, 2 to 6 percent slopes, slightly eroded	164	(1)
Gagetown silt loam, 6 to 12 percent slopes, slightly eroded	57	(1)
Gagetown silt loam, 6 to 12 percent slopes, moderately eroded	49	(1)
Gagetown silt loam, 12 to 18 percent slopes, moderately eroded	40	(1)
Gladwin and Palo sandy loams, 0 to 2 percent slopes	2, 655	. 4
Gladwin and Palo sandy loams, 2 to 7 percent slopes, slightly eroded	1, 408	. 2
Gravel pit	250	(1)
Greenwood peat, 0 to 2 percent slopes	2, 503	. 4
Guelph loam, 0 to 2 percent slopes, slightly eroded	3, 090	. 5
Guelph loam, 2 to 6 percent slopes, slightly eroded	11, 300	1. 8
Guelph loam, 2 to 6 percent slopes, moderately eroded	1, 198	. 2
Guelph loam, 6 to 12 percent slopes, slightly eroded	1, 476	. 2
Guelph loam, 6 to 12 percent slopes, moderately eroded	, 929	. 5
Guelph loam, 6 to 12 percent slopes, severely eroded	138	(1)
Guelph loam, 12 to 18 percent slopes, slightly eroded	118	(1)
Guelph loam, 12 to 18 percent slopes, moderately eroded	196	(1)
Guelph loam, 12 to 18 percent slopes, severely eroded	109	(1)
Guelph loam and silt loam, 0 to 2 percent slopes, slightly eroded	7, 127	1. 2
Guelph loam and silt loam, 0 to 2 percent slopes, moderately eroded	496	. 1
Guelph loam and silt loam, 2 to 6 percent slopes, slightly eroded	15, 808	2. 6
Guelph loam and silt loam, 2 to 6 percent slopes, moderately eroded	8, 546	1. 4

[1] Less than 0. 1 percent.

TABLE 3.—*Approximate acreage and proportionate extent of the soils mapped*—Continued

Mapping unit	Area	Extent	Mapping unit	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Guelph loam and silt loam, 2 to 6 percent slopes, severely eroded	275	(1)	McBride fine sandy loam, 2 to 6 percent slopes, moderately eroded	480	0. 1
Guelph loam and silt loam, 6 to 12 percent slopes, slightly eroded	1, 136	0. 2	McBride fine sandy loam, 6 to 12 percent slopes, slightly eroded	735	. 1
Guelph loam and silt loam, 6 to 12 percent slopes, moderately eroded	6, 488	1. 1	McBride fine sandy loam, 6 to 12 percent slopes, moderately eroded	2, 171	. 4
Guelph loam and silt loam, 6 to 12 percent slopes, severely eroded	1, 800	. 3	McBride fine sandy loam, 12 to 18 percent slopes, slightly eroded	73	(1)
Guelph loam and silt loam, 12 to 18 percent slopes, slightly eroded	203	(1)	McBride fine sandy loam, 12 to 18 percent slopes, moderately eroded	185	(1)
Guelph loam and silt loam, 12 to 18 percent slopes, moderately eroded	695	. 1	McBride fine sandy loam, 12 to 18 percent slopes, severely eroded	89	(1)
Guelph loam and silt loam, 12 to 18 percent slopes, severely eroded	807	. 1	McBride sandy loam and Montcalm loamy sand, 0 to 3 percent slopes, slightly eroded	1, 323	. 2
Guelph loam and silt loam, 18+ percent slopes, slightly eroded	107	(1)	McBride sandy loam and Montcalm loamy sand, 3 to 8 percent slopes, slightly eroded	3, 486	. 6
Guelph loam and silt loam, 18+ percent slopes, moderately eroded	173	(1)	McBride sandy loam and Montcalm loamy sand, 3 to 8 percent slopes, severely eroded	43	(1)
Guelph loam and silt loam, 18+ percent slopes, severely eroded	223	(1)	McBride sandy loam and Montcalm loamy sand, 8 to 15 percent slopes, slightly eroded	953	. 2
Houghton muck, 0 to 2 percent slopes	151	(1)	McBride sandy loam and Montcalm loamy sand, 8 to 15 percent slopes, moderately or severely eroded	93	(1)
Houghton and Palms mucks, 0 to 2 percent slopes	6, 828	1. 1	McBride sandy loam and Montcalm loamy sand, 15 to 25 percent slopes, slightly eroded	178	(1)
Huron silt loam, 2 to 6 percent slopes, slightly eroded	50	(1)	McBride sandy loam and Montcalm loamy sand, 15+ percent slopes, moderately or severely eroded	63	(1)
Iosco sandy loam and Croswell loamy sand, 0 to 2 percent slopes	6, 857	1. 1	McGregor sandy loam, 0 to 2 percent slopes	1, 071	. 2
Iosco sandy loam and Croswell loamy sand, 2 to 7 percent slopes, slightly eroded	970	. 2	McGregor sandy loam, 2 to 6 percent slopes, slightly eroded	28	(1)
Iosco sandy loam and Croswell loamy sand, 7 to 14 percent slopes, slightly eroded	189	(1)	Made land	98	(1)
Iosco sandy loam and Croswell loamy sand, 14+ percent slopes, slightly eroded	14	(1)	Mancelona loamy sand, 0 to 3 percent slopes, slightly eroded	1, 661	. 3
Iosco and Menominee loamy sands, 0 to 2 percent slopes	875	. 1	Mancelona loamy sand, 3 to 8 percent slopes, slightly eroded	4, 573	. 7
Iosco and Menominee loamy sands, 2 to 6 percent slopes, slightly eroded	671	. 1	Mancelona loamy sand, 3 to 8 percent slopes, moderately eroded	77	(1)
Iosco and Winegars sandy loams, 0 to 2 percent slopes	5, 755	. 9	Mancelona loamy sand, 8 to 15 percent slopes, slightly eroded	961	. 2
Iosco and Winegars sandy loams, 2 to 6 percent slopes, slightly eroded	41	(1)	Mancelona loamy sand, 8 to 15 percent slopes, moderately eroded	449	. 1
Jeddo silty clay loam, 0 to 2 percent slopes	4, 581	. 7	Mancelona loamy sand, 15+ percent slopes, slightly eroded	343	. 1
Kalkaska and Wallace fine sands, 0 to 2 percent slopes, slightly eroded	120	(1)	Mancelona loamy sand, 15+ percent slopes, moderately eroded	84	(1)
Kalkaska and Wallace fine sands, 2 to 8 percent slopes, slightly eroded	416	. 1	Mancelona loamy sand, 15+ percent slopes, severely eroded	110	(1)
Kalkaska and Wallace fine sands, 8 to 18 percent slopes, slightly eroded	156	(1)	Marlette loam, 0 to 2 percent slopes, slightly eroded	4, 789	. 8
Kerston muck, 0 to 2 percent slopes	184	(1)	Marlette loam, 2 to 6 percent slopes, slightly eroded	7, 533	1. 2
Lake beach, sandy	180	(1)	Marlette loam, 2 to 6 percent slopes, moderately eroded	224	(1)
Lake beach, rocky	111	(1)	Marlette loam, 2 to 6 percent slopes, severely eroded	75	(1)
Lake beach, stony	44	(1)	Marlette loam, 6 to 12 percent slopes, slightly eroded	1, 002	. 2
Linwood muck, 0 to 2 percent slopes	6, 124	1. 0	Marlette loam, 6 to 12 percent slopes, moderately eroded	677	. 1
Linwood and Tawas mucks, 0 to 2 percent slopes	2, 859	. 5	Marlette loam, 6 to 12 percent slopes, severely eroded	26	(1)
London loam and fine sandy loam, 0 to 2 percent slopes	13, 534	2. 2	Marlette loam, 12 to 18 percent slopes, slightly eroded	106	(1)
London loam and fine sandy loam, 2 to 6 percent slopes, slightly eroded	2, 704	. 4	Marlette loam, 12 to 18 percent slopes, moderately eroded	75	(1)
London loam and fine sandy loam, 2 to 6 percent slopes, moderately eroded	270	(1)	Marlette loam, 12 to 18 percent slopes, severely eroded	106	(1)
London loam and silt loam, 0 to 2 percent slopes	7, 637	1. 2	Marlette loam, 18 to 25 percent slopes, moderately eroded	32	(1)
London loam and silt loam, 2 to 6 percent slopes, slightly eroded	891	. 1	Marlette silt loam and loam, 0 to 2 percent slopes, slightly eroded	4, 961	. 8
London loam and silt loam, 2 to 6 percent slopes, moderately eroded	658	. 1			
London loam and silt loam, 6 to 12 percent slopes, slightly or moderately eroded	66	(1)			
McBride fine sandy loam, 0 to 2 percent slopes, slightly eroded	639	. 1			
McBride fine sandy loam, 2 to 6 percent slopes, slightly eroded	7, 967	1. 3			

[1] Less than 0. 1 percent.

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TABLE 3.—*Approximate acreage and proportionate extent of the soils mapped*—Continued

Mapping unit	Area	Extent
	Acres	*Percent*
Marlette silt loam and loam, 2 to 6 percent slopes, slightly eroded	3, 997	0. 6
Marlette silt loam and loam, 2 to 6 percent slopes, moderately eroded	202	[1]
Marlette silt loam and loam, 6 to 12 percent slopes, slightly eroded	372	. 1
Marlette silt loam and loam, 6 to 12 percent slopes, moderately eroded	85	[1]
Melita and Arenac loamy sands, 0 to 2 percent slopes, slightly eroded	9, 138	1. 5
Melita and Arenac loamy sands, 2 to 7 percent slopes, slightly eroded	3, 186	. 5
Melita loamy sand, 7 to 14 percent slopes, slightly eroded	369	. 1
Melita loamy sand, 14+ percent slopes, slightly to severely eroded	43	[1]
Menominee loamy sand, 6 to 12 percent slopes, slightly eroded	40	[1]
Menominee loamy sand, 6 to 12 percent slopes, moderately eroded	72	[1]
Montcalm loamy sand, 0 to 2 percent slopes, slightly eroded	122	[1]
Montcalm loamy sand, 2 to 6 percent slopes, slightly eroded	3, 605	. 6
Montcalm loamy sand, 2 to 6 percent slopes, moderately eroded	381	. 1
Montcalm loamy sand, 6 to 12 percent slopes, slightly eroded	444	. 1
Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded	634	. 1
Montcalm loamy sand, 12 to 18 percent slopes, slightly eroded	121	[1]
Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded	101	[1]
Newaygo sandy loam, 0 to 2 percent slopes, slightly eroded	1, 206	. 2
Newaygo sandy loam, 2 to 6 percent slopes, slightly eroded	817	. 1
Newaygo sandy loam, 6 to 12 percent slopes, slightly eroded	74	[1]
Newaygo sandy loam, 6 to 12 percent slopes, moderately eroded	32	[1]
Otisco loamy sand, 0 to 2 percent slopes	1, 310	. 2
Otisco loamy sand, 2 to 6 percent slopes, slightly eroded	742	. 1
Palms muck, 0 to 2 percent slopes	3, 184	. 5
Palms and Adrian mucks, 0 to 2 percent slopes	6, 578	1. 1
Parkhill loam, 0 to 2 percent slopes	54, 860	8. 9
Parkhill loam, 2 to 6 percent slopes, slightly eroded	211	[1]
Parkhill loam and clay loam, 0 to 2 percent slopes	112, 602	18. 3
Parkhill loam and mucky loam, 0 to 2 percent slopes	29, 085	4. 7
Perth silt loam, 0 to 2 percent slopes	13	[1]
Richter and Tonkey bouldery sandy loam and loam, 0 to 2 percent slopes	2, 370	. 4
Richter and Tonkey bouldery sandy loam and loam, 2 to 6 percent slopes, slightly eroded	67	[1]
Rifle peat, 0 to 2 percent slopes	2, 159	. 4
Roscommon loamy sand, 0 to 2 percent slopes	2, 328	. 4
Roscommon mucky loamy sand, 0 to 2 percent slopes	3, 460	. 6
Rubicon sand, 0 to 2 percent slopes, slightly eroded	413	0. 1
Rubicon sand, 2 to 7 percent slopes, slightly eroded	1, 777	. 3
Rubicon sand, 2 to 7 percent slopes, moderately or severely eroded	42	[1]
Rubicon sand, 7 to 14 percent slopes, slightly eroded	945	. 2
Rubicon sand, 7 to 14 percent slopes, moderately or severely eroded	123	[1]
Rubicon sand, 14+ percent slopes, slightly eroded	274	[1]
Rubicon sand, 14+ percent slopes, moderately or severely eroded	99	[1]
Sanilac silt loam, 0 to 2 percent slopes	1, 301	. 2
Sanilac silt loam, 2 to 6 percent slopes, slightly eroded	955	. 2
Saverine and Iosco fine sandy loams, 0 to 2 percent slopes	22, 446	3. 6
Saverine and Iosco fine sandy loams, 2 to 7 percent slopes, slightly eroded	2, 934	. 5
Saverine and Iosco fine sandy loams, 2 to 7 percent slopes, moderately eroded	31	[1]
Saverine and Iosco fine sandy loams, 7 to 14 percent slopes, slightly eroded	482	. 1
Saverine and Iosco fine sandy loams, 7 to 14 percent slopes, moderately eroded	143	[1]
Saverine and Iosco fine sandy loams, 14+ percent slopes, slightly eroded	69	[1]
Saverine and Iosco fine sandy loams, 14+ percent slopes, moderately eroded	42	[1]
Spalding peat, 0 to 2 percent slopes	2, 128	. 3
Tappan loam, 0 to 2 percent slopes	1, 031	. 2
Tappan mucky loam, 0 to 2 percent slopes	1, 619	. 3
Tawas muck, 0 to 2 percent slopes	1, 863	. 3
Thomas mucky silt loam, 0 to 2 percent slopes	779	. 1
Tobico mucky loamy sand, 0 to 2 percent slopes	89	[1]
Tonkey sandy loam, 0 to 2 percent slopes	114	[1]
Tonkey and Bach fine sandy loams, 0 to 2 percent slopes	14, 548	2. 4
Tonkey and Bach fine sandy loams, 2 to 7 percent slopes, slightly eroded	27	[1]
Tyre loamy sand and sandy loam, 0 to 2 percent slopes	139	[1]
Tyre loamy sand and sandy loam, 2 to 6 percent slopes, slightly eroded	49	[1]
Tyre loamy sand and sandy loam, 6 to 12 percent slopes, slightly eroded	49	[1]
Wallkill loam, 0 to 2 percent slopes	562	. 1
Warners muck and Marl, 0 to 2 percent slopes	59	[1]
Washtenaw loam and silt loam, 0 to 2 percent slopes	4, 630	. 8
Washtenaw loam and silt loam, 2 to 6 percent slopes	418	. 1
Washtenaw sandy loam and loam, 0 to 2 percent slopes	1, 570	. 3
Washtenaw sandy loam and loam, 2 to 6 percent slopes	73	[1]
Willette muck, 0 to 2 percent slopes	493	. 1
Lakes	19	[1]
Total	615, 040	[2] 99. 2

[1] Less than 0.1 percent.

[2] Because 89 mapping units each have an acreage amounting to less than 0.1 percent of the county, percentages do not total 100.

Adrian Series

Adrian soils were developed in a deposit of fibrous plant materials, 12 to 42 inches thick, that is on sandy mineral materials. The soils are in very poorly drained depressional areas and in old lake basins. The native vegetation was mainly sedges, reeds, and grasses, but there were some dogwoods, alders, willows, and other shrubs.

The mineral materials occur at shallower depths than in the Houghton soils, which developed in more than 42 inches of fibrous organic materials. The mineral materials of the Adrian soils range from sand to loamy sand, whereas those of Palms muck are sandy loam, loam, or coarse clay loam. Adrian soils were formed from fibrous organic materials, but the Tawas soils developed from woody or woody and sedge materials.

Profile description of Adrian muck:

01 0 to 6 inches; muck; black to very dark grayish brown (10YR 2/1 to 3/2, moist); moderate, medium, granular structure; slightly acid to neutral; 6 to 10 inches thick.

02 6 to 20 inches; fibrous peat; dark yellowish brown (10YR 4/4, moist); slightly acid; 5 to 30 inches thick.

03 20 to 26 inches; macerated peat; very dark grayish brown (10YR 3/2, moist); pasty when moist and hard when dry; slightly acid; 4 to 8 inches thick.

D 26 inches+; sand; light gray to light brownish gray (2.5Y 7/2 to 6/2, moist); single grain (structureless); loose; slightly acid to neutral.

The surface horizon contains woody material in many places. Except where the soils are artificially drained, the water table is at or near the surface. The organic material is generally slightly acid, but it ranges from medium acid to neutral.

Adrian muck is used for permanent pasture. Marsh hay is cut in some places. A few areas have been drained and are used for special crops, such as vegetables, potatoes, onions, and mint.

MAPPING UNIT

AaA0 Adrian muck, 0 to 2 percent slopes. Soil management unit M/4c(IVW).

Alluvial Land

Alluvial land occurs in narrow, winding areas on alluvial flood plains. Because deposits are washed from adjacent upland areas, the textures are similar to those of the upland soils. Alluvial land has a relatively dark colored surface layer that is underlain by grayish stratified material. The stratification is the result of deposition rather than of profile development. The texture of the underlying stratified material is generally similar to that at the surface. Some areas are calcareous at or near the surface.

This land is moderately well drained to poorly drained, according to how high it is above the adjacent stream. In spring, many areas are flooded by waters from melting snow or heavy rains. The native vegetation consisted of northern hardwoods, mainly elm, ash, and maple. Some conifers occur in poorly drained sites.

Alluvial land is poorly suited to field crops because of drainage problems, hazard of flooding, and narrowness of the areas. Cleared areas are used mostly for unimproved pasture (fig. 2). Most of the wooded areas are pastured. The condition of the second-growth forest indicates that the woodlands have been poorly managed. Many narrow strips of Alluvial land are too small to be shown on the soil map.

Figure 2.—**Alluvial land along Big Creek in Marion Township. The upland soils in the background are Guelph loams.**

MAPPING UNITS

AbA0 Alluvial land, poorly drained loams, 0 to 2 percent slopes. This is the most extensive mapping unit of Alluvial land in the county. It is only slightly above stream level and is flooded more frequently than other Alluvial lands. It is on the wider parts of the flood plains where the slow-moving waters deposit medium- and fine-textured materials. Soil management unit L3c (VW).

AbB0 Alluvial land, poorly drained loams, 2 to 6 percent slopes. This land occupies the outer parts of the flood plains adjacent to upland soils. Soil management unit L3c (VW).

AcA0 Alluvial land, imperfectly or moderately well drained sandy loams, 0 to 2 percent slopes. This land is on second bottoms, which are remnants of flood plains that existed before the streams cut deeper into the valleys. It is slightly above the normal level of the flood plains and is covered by water only in very rainy periods. Soil management unit L3b(IIIW).

AcB0 Alluvial land, imperfectly or moderately well drained sandy loams, 2 to 6 percent slopes. This land is similar to Alluvial land, imperfectly or moderately well drained sandy loams, 0 to 2 percent slopes, except that it occurs on gentle to very gentle slopes. It is on the outer parts of flood plains adjacent to the upland soils. Soil management unit L3b(IIIW).

AdA0 Alluvial land, poorly drained sandy loams, 0 to 2 percent slopes. This land is only slightly above stream level and is frequently flooded. When they overflow, the streams undercut the land and deposit new materials. Soil management unit L3c(VW).

AdB0 Alluvial land, poorly drained sandy loams, 2 to 6 percent slopes. This land is on the outer parts of the flood plains adjacent to upland soils. Soil management unit L3c(VW).

Au Gres and Saugatuck Series

Au Gres and Saugatuck loamy sands, in this county, are mapped together. These imperfectly drained soils developed from loose sands more than 66 inches deep. They are on level or nearly level outwash and old lake plains. The Saugatuck soils differ from the Au Gres soils in that

they have a strongly cemented horizon in the subsoil. The depth to the water table varies from 2 to 5 feet, depending on the season. The native vegetation was mainly white pine but included some elm, red maple, and hemlock. The second growth is mostly aspen. The more open areas have a dense growth of bracken fern.

These soils are the imperfectly drained member of the natural toposequence that includes the well drained Kalkaska and Rubicon soils, the moderately well drained Croswell soils, and the poorly drained to very poorly drained Roscommon soils. The Au Gres and Saugatuck soils are coarser textured than the Tonkey and Bach soils, and their surface layer is lighter colored. In reaction and in degree of profile development, they differ from the Tonkey and Bach soils, which have a neutral or calcareous surface layer and lack the distinct A_2 and B_{hg} horizons. The Au Gres and Saugatuck soils are generally deeper than the well drained and moderately well drained Melita soils and the imperfectly drained Arenac soils, which have loam to clay materials at depths of 42 to 66 inches. The Au Gres and Saugatuck soils are also deeper than the imperfectly drained Saverine and Iosco soils, which developed from sands, loamy sands, and fine sandy loams that are 18 to 42 inches deep over loam to silty clay loam.

Profile description of an Au Gres loamy sand:

A_1 0 to 5 inches; loamy sand; dark gray to black (10YR 4/1 to 2/1, moist); weak, fine, granular structure; very friable when moist and soft to loose when dry; medium content of organic matter; medium to strongly acid; 4 to 9 inches thick.

A_2 5 to 9 inches; sand; light brownish gray, light gray, or white (10YR 6/2, 7/2, or 8/1, moist); weak, thin, platy structure to single grain (structureless); loose; medium to strongly acid; 3 to 9 inches thick.

B_{21hg} 9 to 13 inches; sand to loamy sand; reddish brown, strong brown, yellowish brown, or grayish brown (5YR 4/3, 7.5YR 5/6, 10YR 5/4 or 5/2, moist), mottled with very dark grayish brown to dark yellowish brown (10YR 3/2 to 4/4, moist); weak, fine, granular structure; some humus and iron cementation; very friable when moist and loose when dry; frequently shows accumulation of organic matter; medium to strongly acid; 3 to 6 inches thick.

B_{22hg} 13 to 24 inches; sand; brown, dark brown, or strong brown (7.5YR 4/4 or 5/6, moist), mottled with very dark grayish brown to yellowish brown (10YR 3/2 to 5/4, moist); single grain (structureless); loose; medium acid; 4 to 16 inches thick.

C_{1g} 24 inches+; sand; light yellowish brown to very pale brown (10YR 6/4 to 7/3, moist), mottled with brown (10YR 5/3, moist); single grain (structureless); loose; medium acid to neutral.

The horizons, especially the B_{22hg} horizon, vary in thickness. The B_{21hg} horizon varies in degree of development. The Saugatuck soils are similar to Au Gres soils, except that they have a thicker B_{21hg} horizon that is very strongly cemented. This horizon hinders the development of plant roots. Runoff is slow and permeability is rapid.

Au Gres and Saugatuck soils occur in small areas and are used the same way as the adjoining sandy soils. Most cleared areas are used for unimproved permanent pasture. In spring these soils are moderately well suited to pasture, but in summer the animal-carrying capacity per acre is low. Because they have low moisture-holding capacity and low natural fertility, they are not well suited to crops. Yields are low or crops fail completely unless rainfall is adequate and well distributed throughout the growing season. Some cleared areas are no longer cropped.

MAPPING UNITS

AeA0 Au Gres and Saugatuck loamy sands, 0 to 2 percent slopes. Soil management unit 5bA(IVW).

AeB1 Au Gres and Saugatuck loamy sands, 2 to 6 percent slopes, slightly eroded. Soil management unit 5bA(IVW).

Bach Series

Bach soils were developed on stratified, calcareous silts and fine sands, and some clay. These soils are in nearly level or in depressional areas on the lake plains. The native vegetation consisted of elm, ash, red maple, and some basswood.

Bach soils are the poorly to very poorly drained member of the natural toposequence that includes the moderately well drained Gagetown and the imperfectly drained Sanilac soils. They are calcareous at or within 10 inches of the surface. Bach soils differ from Tappan soils, which developed on loam till, and from the Tonkey soils, which formed from stratified sands, loamy sands, and sandy loams.

Profile description of a Bach silt loam:

A_p 0 to 7 inches; silt loam; very dark gray to dark gray (10YR 3/1 to 4/1, moist); moderate, fine, granular structure; friable when moist and soft when dry; neutral to calcareous; 6 to 8 inches thick.

GA 7 to 20 inches; very fine sandy loam to silt loam; grayish brown to very dark gray (2.5Y 5/2 to 10YR 3/1, moist); moderate, medium, granular structure; friable when moist and soft when dry; calcareous; 10 to 15 inches thick.

GB 20 to 34 inches; very fine sandy loam to silt loam; gray to light gray (5Y 5/1 to 10YR 6/1, moist), mottled with brown (10YR 5/3, moist); weak, medium, subangular blocky structure; friable when moist and slightly hard when dry; calcareous; 10 to 15 inches thick.

C 34 inches+; very fine sand, silt, fine sand, and some clay; gray to light gray (5Y 5/1 to 10YR 6/1, moist); stratified; calcareous.

The texture of the plow layer ranges from fine sandy loam to silt loam.

The principal crops on the adequately drained areas are corn, wheat, oats, sugar beets, dry beans, alfalfa, and clover. Other cleared areas that formerly had a shallow organic covering have been burned over and are now used mainly for unimproved permanent pasture.

MAPPING UNIT

BaA0 Bach silt loam, 0 to 2 percent slopes. Soil management unit 3cA(IIW).

Capac Series

Capac soils have imperfect natural drainage. They were developed from calcareous loam glacial till, normally on level to gently sloping till plains. The native vegetation consisted mainly of northern hardwoods but included some white pine and hemlock.

Capac soils are associated with Parkhill and Jeddo soils, which occur in depressions and have poor to very poor natural drainage. Capac soils are the imperfectly drained member of the natural toposequence that includes the well to moderately well drained Marlette and poorly drained Parkhill soils. They occur with the well-drained Marlette soils that are on gentle to moderate slopes. The Capac soils are darker colored in the surface layer than the

Marlette soils and are slightly lighter colored in the surface layer than the Parkhill and Jeddo soils. Carbonates are at depths of 25 to 45 inches in the Capac soils, but at depths of 15 to 25 inches in the London soils.

Profile description of a Capac loam:

A_p 0 to 8 inches; loam; very dark grayish brown to very dark brown (10YR 3/2 to 2/2, moist); weak, medium to coarse, granular structure; friable when moist and soft when dry; medium to slightly acid; 6 to 9 inches thick.

B_{2hg} 8 to 10 inches; loam; grayish brown to yellowish brown (2.5Y 5/2 to 10YR 5/8, moist), mottled with light olive brown to brownish yellow (2.5Y 5/4 to 10YR 6/6, moist); moderate, medium, granular structure to weak, thin, platy structure; friable when moist and soft when dry; medium to slightly acid; 2 to 4 inches thick.

B_{1tg} 10 to 14 inches; loam to silty clay loam; grayish brown to yellowish brown (2.5Y 5/2 to 10YR 5/4 or 5/8, moist), mottled with yellowish brown, light brownish gray, and brownish yellow (10YR 5/4 or 5/6, 6/2 and 6/6 moist); moderate, medium, subangular blocky structure; plastic when wet, friable when moist, and slightly hard when dry; medium to slightly acid; 3 to 5 inches thick.

B_{21tg} 14 to 22 inches; clay loam to silty clay loam; grayish brown to yellowish brown (2.5Y 5/2 to 10YR 5/4 or 5/6, moist), mottled with brown, yellowish brown, light brownish gray, or brownish yellow (10YR 5/3, 5/4, 6/2, or 6/6, moist); moderate, medium to coarse, angular blocky structure; plastic when wet, firm when moist, and very hard when dry; slightly acid to neutral; 5 to 10 inches thick.

B_{3tg} 22 to 35 inches; loam to silty clay loam; yellowish brown, gray, or light gray (10YR 5/6, 5/8, or 6/1, moist), mottled with gray, light gray, light brownish gray, and brownish yellow (10YR 5/1, 6/1, 6/2, and 6/6, moist); moderate, coarse, angular blocky structure; plastic when wet, firm when moist, and very hard when dry; slightly acid to neutral; 10 to 15 inches thick.

C_g 35 inches+; loam to coarse clay loam; light olive brown to yellowish brown (2.5Y 5/4 to 10YR 5/4, moist), mottled with gray (10YR 5/1, moist); moderate, coarse, angular blocky structure; firm when moist and hard when dry; calcareous.

The texture of the plow layer ranges from fine sandy loam to silt loam. Areas of Capac soil that have a fine sandy loam plow layer generally have a deeper solum than areas with a finer textured plow layer.

Areas of Capac soils that have been drained are used mainly for corn, wheat, oats, sugar beets, and dry beans. The rest of the acreage is in permanent pasture or farm woodlots.

MAPPING UNITS

CaA0 Capac loam and fine sandy loam, 0 to 2 percent slopes. Soil management unit 2bA(I).

CaB1 Capac loam and fine sandy loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2bB(IIW).

CaC2 Capac loam and fine sandy loam, 6 to 12 percent slopes, moderately eroded. These soils occur on slopes along natural drainageways. Erosion has reduced the thickness of the surface layer, and some of the finer textured subsoil (B_{tg} horizon) is in the plow layer. Crop yields are generally less than on the uneroded Capac soils. Soil management unit 2bB(IIW).

CbA0 Capac silt loam and loam, 0 to 2 percent slopes. Soil management unit 2bA(I).

CbB1 Capac silt loam and loam, 2 to 6 percent slopes, slightly eroded. A few small areas with slopes of 6 to 12 percent along drainageways are included. Soil management unit 2bB(IIW).

CbB2 Capac silt loam and loam, 2 to 6 percent slopes, moderately eroded. These soils occur along drainageways. Erosion has reduced the thickness of the surface layer, and part of the fine-textured subsoil (B_{tg} horizon) is in the plow layer. Crop yields are generally lower than on the less eroded soils. Soil management unit 2bB(IIW).

Carlisle Series

Carlisle soils developed mostly from woody and fibrous organic materials that are more than 42 inches thick. They are very poorly drained and occur in old lakebeds, drainageways, and other depressional areas. The native vegetation was mainly dense stands of elm, black ash, red maple, swamp oak, and white oak with some basswood.

These soils have different parent material than the Houghton soils, which were developed from fibrous grasses, reeds, and sedges. The organic materials in the surface layer of Carlisle soils are more decomposed than those of the Rifle soils.

Profile description of Carlisle muck:

01 0 to 15 inches; muck; black (10YR 2/1, moist); moderate, fine, granular structure; friable when moist and loose when dry; many partly decayed, various-sized, woody fragments; medium acid to neutral; 12 to 24 inches thick.

02 15 to 25 inches; muck to peat; black to very dark brown (10YR 2/1 to 2/2, moist); woody material abundant in upper part; easily distinguishable fibrous plant remains in the lower part; slightly acid to neutral; 4 to 16 inches thick.

03 25 inches+; yellowish brown to dark yellowish brown (10YR 5/8 to 4/4, moist); peat that consists mostly of remains of grasses and sedges; amount of decomposition decreases with increasing depth; medium acid to neutral in reaction.

Silty overwash has increased the mineral content of the surface layer in many places. In many areas the muck grades into poorly drained mineral soil. Most of the time, the water table is at or near the surface.

Cleared and drained areas are used mostly for special crops and pasture. The rest of the acreage is in second-growth forest. If adequately drained and fertilized, the muck areas can be used for onions, mint, sugar beets, potatoes, and truck crops. Control of wind erosion is needed if this muck is cropped.

MAPPING UNIT

CcA0 Carlisle muck, 0 to 2 percent slopes. Soil management unit Mc(IIIW).

Carlisle and Linwood Series

Carlisle muck and Linwood muck are mapped together as a group of undifferentiated soils. These mucks were developed from mixed woody and fibrous organic material—the Carlisle muck in organic materials more than 42 inches deep, and the Linwood muck in organic materials 12 to 42 inches deep. Linwood muck has medium-textured mineral materials below the organic materials.

These soils are in poorly to very poorly drained depressions along large natural drainageways, and in isolated depressions. The native vegetation consisted of a dense stand of elm, ash, red maple, and swamp white oak, with some basswood.

The Carlisle and Linwood mucks were developed from woody and fibrous organic material, while the Houghton and Palms mucks were developed from reedy and sedgy materials. A profile of a Carlisle muck is described under the heading, Carlisle Series.

Profile of a Linwood muck:

01 0 to 12 inches; muck; black (10YR 2/1, moist); moderate, medium, granular structure; friable when moist and loose when dry; medium acid to neutral; 10 to 15 inches thick.

02 12 to 25 inches; muck and peat; black to very dark brown (10YR 2/1 to 2/2, moist); slightly acid; 8 to 15 inches thick.

03 25 to 29 inches; sedimentary peat; very dark gray (5Y 3/1, moist); pulpy; slightly acid; 3 to 6 inches thick.

D 29 inches+; loam to silty clay loam; olive (5Y 5/3, moist), mottled with yellowish brown (10YR 5/4, moist); massive (structureless); sticky when wet and firm when moist; calcareous.

The organic material in Linwood muck ranges from 12 to 42 inches in thickness. The texture of the underlying mineral materials ranges from fine sandy loam to silty clay loam. Most of the time, the water table is at or near the surface.

Cleared and drained areas of Carlisle and Linwood mucks are used mostly for special crops and pasture. If these soils are adequately fertilized, they can be used for onions, mint, corn, sugar beets, potatoes, and truck crops. Crops on these soils are likely to be damaged by frost more frequently than on mineral soils of the adjacent upland. Because early frost interferes with proper ripening of the grain, corn is normally harvested for silage. Control of wind erosion is needed if these soils are cropped. On areas of Linwood muck, which are shallow, rapid decomposition may decrease the thickness of the organic layer and thereby lessen the suitability of this soil for some crops. Many crops, however, can obtain nutrients from the underlying mineral materials. Bluegrass, alsike clover, and reed canarygrass furnish good pasture in summer and in fall.

MAPPING UNIT

CdA0 Carlisle and Linwood mucks, 0 to 2 percent slopes. Soil management unit Mc(IIIW).

Clay Pit

Only one small clay pit was mapped in Sanilac County. This miscellaneous land type is immediately northeast of Sandusky. The original profile has been destroyed by the removal of clay.

MAPPING UNIT

Ce Clay pit. Soil management group S(VIIIS).

Coral Series

In the Coral series are imperfectly drained soils that were developed from calcareous sandy loam till.

Coral soils are in the same natural toposequence as the well-drained McBride soils and the poorly to very poorly drained Ensley soils. Coral soils are finer textured throughout the soil profile than Otisco soils, which were developed from loamy sands. They are not so fine textured as the Capac and London soils, which were developed from loam till. The native vegetation was mainly northern hardwoods but included some white pine. The second-growth forest is mainly aspen.

Profile description of a Coral fine sandy loam:

A_1 0 to 4 inches; fine sandy loam; very dark gray to dark grayish brown (10YR 3/1 to 4/2, moist); weak, medium, granular structure; friable when moist and soft when dry; medium in organic-matter content; medium to slightly acid; 2 to 6 inches thick.

A_2 4 to 6 inches; fine sandy loam; light yellowish brown to dark grayish brown (10YR 6/4 to 4/2, moist); weak, thin, platy structure; friable when moist and hard when dry; strongly to slightly acid; 1 to 4 inches thick.

B_{2h} 6 to 11 inches; fine sandy loam; dark brown, brown, or dark reddish brown (7.5YR 4/4 or 5YR 3/2, moist); weak, very thin, platy structure; slight cementation; friable to firm when moist and hard when dry; strongly to slightly acid; 4 to 6 inches thick.

A_2 11 to 14 inches; fine sandy loam; pale brown to very pale brown (10YR 6/3 to 7/3, moist); weak, thin, platy structure; friable when moist, compact and hard when dry; strongly to slightly acid; 2 to 8 inches thick.

B_{2tg} 14 to 23 inches; sandy clay loam; light brownish gray to strong brown (10YR 6/2 to 7.5YR 5/6, moist), mottled with light brownish gray (2.5Y 6/2, moist); moderate, coarse, angular blocky structure; plastic when wet, firm when moist, and hard when dry; slightly acid to neutral; 6 to 15 inches thick.

C_g 23 inches+; sandy loam; yellowish brown (10YR 5/6, moist), mottled with light brownish gray (2.5Y 6/2, moist); weak, medium, granular structure to structureless; friable when moist and hard when dry; calcareous.

The surface layer varies in thickness and in content of organic matter. In some areas, plowing has mixed the upper A_2 horizon into the surface layer. Stones and gravel occur on the surface but not in quantities large enough to interfere with tillage. The depth to the carbonates, or limy material, ranges from 22 to 45 inches. External drainage is moderately slow and internal drainage is slow.

Most of the acreage in Coral soils is cleared and cropped. Corn, oats, field beans, alfalfa, and clover are the main crops. About one-fifth of the acreage is either in permanent pasture or in farm woodlots.

MAPPING UNITS

CfA0 Coral fine sandy loam, 0 to 2 percent slopes. Soil management unit 3bA(IIW).

CfB1 Coral fine sandy loam, 2 to 6 percent slopes, slightly eroded. Included with this soil are small areas that are more than slightly eroded. The dominant slopes are less than 4 percent. Soil management unit 3bB(IIW).

Croswell Series

Croswell soils are moderately well drained and were developed from deep sands. They occur on lake plains or old shorelines of glacial lakes. The native vegetation was mainly white, red, and jack pines but included some oak.

Croswell soils are in the natural toposequence that includes the well-drained Rubicon and Kalkaska soils, the imperfectly drained Au Gres and Saugatuck soils, and the poorly and very poorly drained Roscommon soils.

Profile description of a Croswell loamy sand:

A_1 0 to 2 inches; loamy sand; very dark gray to very dark grayish brown (10YR 3/1 to 3/2, moist); weak, fine, granular structure; very friable when moist and soft when dry; medium to strongly acid; ½ to 3 inches thick.

A_2 2 to 6 inches; fine sand to loamy fine sand; light gray to light brownish gray (5YR 7/1 to 10YR 6/2, moist); single grain (structureless); loose; medium to strongly acid; 2 to 8 inches thick.

B_{21h} 6 to 12 inches; fine sand to loamy fine sand; reddish brown to yellowish brown (5YR 4/4 to 10YR 5/6, moist); very weak, medium, granular structure to single grain (structureless); some slightly to moderately cemented fragments; strongly acid; 3 to 7 inches thick.

B_{22h} 12 to 24 inches; sand to fine sand; dark brown to brown (10YR 4/3, moist); single grain (structureless); loose; medium acid; 6 to 18 inches thick.

C_{1g} 24 inches+; sand to fine sand; light yellowish brown (10YR 6/4, moist), mottled with yellowish brown (10YR

5/8, moist) and reddish yellow (7.5YR 6/8, moist); intensity of mottling increases with depth; single grain (structureless); loose; medium to slightly acid.

The texture of the surface layer ranges from sand to loamy sand. Throughout the profile, the texture of the soil ranges from loamy fine sand to coarse sand. In many places the parent material appears to be stratified. Calcareous sands frequently occur below depths of 60 to 72 inches. Because the water table is relatively high, the lower part of the profile is mottled. The depth to the mottling ranges from 24 to 40 inches. The Croswell soils are deepest to mottling where they grade into the Rubicon soils and are shallowest to mottling where they grade into the Au Gres soils. Croswell soils have very low moisture-holding capacity and low productivity. External drainage is good.

Croswell soils are mainly in second-growth forest, shrubs, and permanent pasture. Much of the acreage was formerly cleared and farmed, but many areas are now idle or are used for limited grazing. White and red pines have been planted on a few of the abandoned areas. If Croswell soils are to be used for cultivated crops, a soil-building program should be followed. Management is needed to control wind erosion, to maintain fertility, and to supply organic matter.

MAPPING UNITS

CgA1 Croswell loamy sand, 0 to 2 percent slopes, slightly eroded. Soil management unit 5aA(IVS).

CgB1 Croswell loamy sand, 2 to 7 percent slopes, slightly eroded. Soil management unit 5aB(IVS).

Eastport, Arenac, and Kalkaska Series

Where Eastport, Arenac, and Kalkaska sands are closely associated in Sanilac County, they were mapped together as undifferentiated soils.

Eastport soils are well drained and were developed from deep sands. They occur on beach ridges that are only slightly higher than Lake Huron. They have little horizon development. In many places, they are neutral to alkaline throughout the profile. The Arenac soils are imperfectly drained and were developed from sands that are 42 to 66 inches deep over loams to clays. The Kalkaska soils are well drained and were developed from deep sands.

The native vegetation was mixed deciduous and coniferous trees. The second growth is mostly staghorn sumac and aspen. A representative profile of Eastport fine sand is described under the heading, Eastport Series and Beach sand; one of a Kalkaska fine sand is described under the heading, Kalkaska and Wallace Series.

Profile description of an Arenac sand:

A_1 0 to 3 inches; sand; very dark gray to very dark brown (10YR 3/1 to 2/2, moist); weak, fine, granular structure; very friable when moist and soft when dry; medium to slightly acid; 1 to 3 inches thick.

A_2 3 to 7 inches; sand; light gray to dark grayish brown (10YR 7/2 to 4/2, moist); single grain (structureless); loose; strongly to slightly acid; 2 to 6 inches thick.

B_{21h} 7 to 12 inches; sand; dark brown, brown, or strong brown (7.5YR 3/2, 5/4, or 5/8, moist); very weak, coarse, granular structure to single grain (structureless); very friable when moist and loose when dry; strongly to slightly acid; 3 to 8 inches thick.

B_{22hg} 12 to 24 inches; sand; dark yellowish brown, dark brown, brown, or yellowish brown (10YR 4/4, 4/3, or 5/6, moist), mottled with strong brown and reddish yellow (7.5YR 5/8 and 7/8, moist); single grain (structureless); loose; medium to slightly acid; 5 to 20 inches thick.

C_{1g} 24 to 54 inches; sand; light yellowish brown to light gray (10YR 6/4 to 7/2, moist), mottled with brownish yellow (10YR 6/6 or 6/8, moist); single grain (structureless); loose; slightly acid to mildly alkaline; 20 to 36 inches thick.

D 54 inches+; loam to clay; light brownish gray, brown, or light olive brown (10YR 6/2, 5/3, or 2.5Y 5/4, moist); moderate, coarse, angular blocky structure; plastic when wet, firm when moist, and hard to very hard when dry; calcareous.

The thickness of horizons varies considerably. The reaction is strongly acid to calcareous. The permeability is rapid to very rapid.

The Eastport, Arenac, and Kalkaska soils are limited in their use for crops because of susceptibility to wind erosion, lack of plant nutrients, and very low moisture-holding capacity. Areas that had been cleared and farmed are now idle or are used for limited grazing. Most areas are covered with second-growth trees and shrubs. The areas along Lake Huron provide excellent sites for summer cottages and homes.

MAPPING UNITS

EaA1 Eastport, Arenac, and Kalkaska sands, 0 to 2 percent slopes, slightly eroded. Arenac soils are prominent in this mapping unit. Soil management unit 5.3aA(VIIS).

EaB1 Eastport, Arenac, and Kalkaska sands, 2 to 7 percent slopes, slightly eroded. Soil management unit 5.3a(VIIS).

EaC1 Eastport, Arenac, and Kalkaska sands, 7 to 14 percent slopes, slightly eroded. These areas are composed of a series of long, narrow, steep-sided beach ridges that have intervening swales. The Arenac soils make up only a small part of this mapping unit. Soil management unit 5.3aC(VIIS).

Eastport Series and Beach Sand

Eastport soils and Beach sands are mapped together as an undifferentiated unit. They are well to imperfectly drained and occur along the shores of Lake Huron. These soils were developed from deep sands on gently sloping plains that are only slightly higher than the present beach. Eastport soils have slight profile development, but the younger beach sands have little or none. The vegetation consists of a sparse growth of grass and scattered scrub oak, aspen, and sumac.

Profile description of an Eastport fine sand:

A_1 0 to 3 inches; fine sand; very dark gray (10YR 3/1, moist); contains an appreciable amount of organic matter; single grain (structureless); loose; neutral to mildly alkaline; ½ to 3 inches thick.

A_2 3 to 18 inches; fine sand; gray (10YR 5/1, moist); single grain (structureless); loose; neutral to mildly alkaline; 4 to 18 inches thick.

B_{2h} 18 to 30 inches; fine sand; yellow to light brown (10YR 7/6 to 7.5YR 6/4, moist); single grain (structureless); loose; neutral to calcareous; 2 to 20 inches thick.

C 30 inches+; fine sand; pale yellow to gray (2.5Y 7/4 to 10YR 5/1, moist); single grain (structureless); stratified; loose; neutral to calcareous.

In places the water table is at depths of 3 to 6 feet. These soils are not used for crops. Their main use is for recreational purposes. The higher areas provide good building sites.

MAPPING UNITS

EbA0 Eastport fine sand and Beach sand, 0 to 2 percent slopes. Soil management unit 5.3aA(VIIS).

EbC0 Eastport fine sand and Beach sand, 2 to 18 percent slopes. These soils are on slopes between more nearly

level areas of Eastport sand and the Beach sand. The dominant slopes range from 2 to 6 percent. Soil management unit 5.3aC(VIIS).

Edmore and Ensley Series

Edmore soils and Ensley soils are mapped together in Sanilac County as groups of undifferentiated soils. These soils have poor natural drainage and occur in drainageways, depressions, and basins. The Edmore soils developed from loamy sand parent material, and the Ensley soils developed from sandy loam parent material. The native vegetation was mainly elm, ash, swamp white oak, silver maple, and red maple.

The Edmore soils are the dark-colored, poorly drained member of the natural toposequence that includes the well-drained Montcalm and the imperfectly drained Otisco soils. The Ensley soils are the dark-colored, poorly drained members of the natural toposequence that includes the well-drained McBride and the imperfectly drained Coral soils. Edmore and Ensley soils are similar to Tonkey and Bach soils in drainage, but they are more acid in the surface layer and have less stratified parent material.

Profile description of an Ensley sandy loam:

A_p 0 to 8 inches; sandy loam; very dark gray to very dark grayish brown (10YR 3/1 to 3/2, moist); weak, coarse, granular structure; very friable when moist and soft when dry; high in organic matter; slightly acid; 6 to 10 inches thick.

GA 8 to 18 inches; loamy sand to sandy loam; gray, light gray, or light brownish gray (10YR 6/1 or 6/2, moist), mottled with yellow, reddish yellow, and light brown (10YR 7/6, 7.5YR 6/6, and 6/4, moist); very weak, thick, platy structure; friable when moist and slightly hard when dry; neutral; 6 to 14 inches thick.

GB 18 to 26 inches; sandy clay loam; olive gray (5Y 5/2, moist), mottled with reddish brown (5YR 5/4, moist); weak, coarse, angular blocky structure; plastic when wet and firm when moist; neutral; 6 to 20 inches thick.

C 26 inches+; sandy loam; yellowish brown (10YR 5/4, moist), mottled with olive gray (5Y 5/2, moist); massive (structureless); neutral to calcareous.

The texture of the surface soil ranges from sandy loam to loam. In many places there are lenses of silty material in the parent material. Included with these soils are some areas that have a sandy loam surface layer underlain by loam.

Profile description of an Edmore sandy loam:

A_p 0 to 8 inches; sandy loam; dark gray to very dark grayish brown (10YR 4/1 to 3/2, moist); weak to moderate, medium, granular structure; very friable when moist; high in organic matter; slightly acid to neutral; 6 to 9 inches thick.

GA 8 to 18 inches; loamy sand; light gray to light brownish gray (10YR 7/2 to 6/2, moist), mottled with yellowish brown and yellow (10YR 5/8 and 7/6, moist); very weak, fine, granular structure; very friable to loose when moist; neutral; 6 to 12 inches thick.

GB_1 18 to 26 inches; sandy loam; light yellowish brown to light brownish gray (10YR 6/4 to 6/2, moist), mottled with brownish yellow and light gray (10YR 6/8 and 7/2, moist); weak to moderate, medium, subangular blocky structure; friable when moist; neutral to mildly alkaline; 4 to 16 inches thick.

GB_2 26 to 44 inches; sand; light gray to light brownish gray (10YR 7/2 to 6/2, moist), mottled with yellow and brownish yellow (10YR 7/8 and 6/6, moist); stratified with thin lenses of loamy sand and sandy loam; very friable to loose when moist; neutral to mildly alkaline; 15 to 30 inches.

C 44 inches+; sand, loamy sand, and sandy loam; light gray to light brownish gray (10YR 7/2 to 6/2, moist); stratified; friable to loose when moist; calcareous.

Runoff is slow to very slow. In spring, the water table is at or near the surface.

About half the acreage of Edmore and Ensley sandy loams is used for rotation crops. The rest is used for permanent pasture or farm woodlots. If these soils are cropped, drainage is the main problem. Tile tends to fill with sand, and ditchbanks are difficult to maintain.

MAPPING UNITS

EcA0 Edmore and Ensley sandy loams, 0 to 2 percent slopes. Soil management unit 4cA(IIIW).

EcB1 Edmore and Ensley sandy loams, 2 to 6 percent slopes, slightly eroded. These soils occur on gently sloping to very gently sloping areas that have better drainage than the more nearly level Edmore and Ensley soils. These areas probably had higher water tables at one time. Soil management unit 4cB(IIIW).

Edwards Series

In the Edwards series are organic soils that are 12 to 42 inches deep over marl. These soils were developed in poorly and very poorly drained depressions and drainageways. Their upper organic layers are similar to those of Carlisle muck, which is more than 42 inches deep.

In areas where the muck is shallowest over marl, the native vegetation was mainly marsh grasses, reeds, and sedges. Where the muck is deeper, the native vegetation was mainly elm, ash, swamp white oak, and aspen.

Profile description of an Edwards muck:

01 0 to 6 inches; muck and some woody plant remains; very dark grayish brown to black (10YR 3/2 to 2/1, moist); well decomposed; moderate, medium, granular structure; friable when moist; neutral to moderately alkaline; 5 to 12 inches thick.

02 6 to 20 inches; muck; very dark brown to very dark grayish brown (10YR 2/2 to 3/2, moist); moderately decomposed plant remains and woody material with its original form discernible; moderate, coarse, granular structure; somewhat dense in places; neutral to moderately alkaline; 6 to 30 inches thick.

D 20 inches+; marl; gray (10YR 5/1, moist); generally contains shells; massive (structureless); calcareous.

The muck varies from 12 to 42 inches in thickness. Where marl occurs at depths of 27 to 42 inches, a brown, fibrous peat normally occurs above the marl.

Most of Edwards muck is in permanent pasture or second-growth forest. Some deeper areas associated with Carlisle muck are used for special crops and field crops. Muck soils, however, are of limited use for crops because of poor drainage, frost hazard, and low fertility. Where drained, they are susceptible to wind erosion. In places, the underlying marl is a source of lime.

MAPPING UNIT

EdA0 Edwards muck, 0 to 2 percent slopes. Soil management unit M/mc(IVW).

Epoufette and Ronald Series

Epoufette and Ronald soils are mapped together in Sanilac County as undifferentiated soils. They were developed on deep, stratified sand and gravel on old deltas and beach ridges that have been affected by glaciers.

These soils are in transitional areas between the nearly level areas in the central part of the county and the morainic uplands east of the Black River. They are poorly and very poorly drained. The Epoufette soils were developed from calcareous loamy sand that is 18 to 42 inches deep over sand and gravel. Ronald soils were developed from calcareous sandy loam to loam that is 18 to 42 inches deep over stratified, limy gravel and sand. The native vegetation was mostly elm and ash but included some swamp conifers.

These soils are generally associated with the well-drained Mancelona and Newaygo soils and the imperfectly drained Gladwin and Palo soils. The Ronald soils are the poorly drained member of the natural toposequence that includes the well-drained Newaygo soils and the imperfectly drained Palo soils.

The Epoufette soils are the poorly drained members of the natural toposequence that includes the well-drained Mancelona and the imperfectly drained Gladwin soils.

Profile description of an Epoufette sandy loam:

A_p 0 to 7 inches; sandy loam; black to very dark gray (10YR 2/1 to 3/1, moist); contains some gravel; moderate, medium, granular structure; friable when moist and soft when dry; low to high content of organic matter; neutral; 5 to 8 inches thick.

GA 7 to 16 inches; gravelly loamy sand; olive gray to grayish brown (5Y 5/2 to 2.5Y 5/2, moist), mottled with brown, yellowish brown, and light olive brown (10YR 5/3, 5/4, and 2.5Y 5/4, moist); very weak, fine, granular structure to single grain (structureless); friable when moist; neutral; 6 to 12 inches thick.

GB 16 to 20 inches, gravelly sandy loam; light brownish gray, pale brown, or brown (2.5Y 6/2, 10YR 6/3, or 5/3, moist), mottled with olive brown, brown, and dark yellowish brown (2.5Y 4/4, 10YR 5/3, and 4/4, moist); weak, medium, subangular blocky structure; slightly sticky when wet; neutral to calcareous; 2 to 8 inches thick.

GC 20 to 30 inches; gravelly sand to loamy sand; grayish brown (2.5Y 5/2, moist), mottled with light olive brown and olive brown (2.5Y 5/6 and 4/4, moist); loose; calcareous; 2 to 14 inches thick.

D 30 inches+; sand and gravel; grayish brown (2.5Y 5/2, moist); stratified; loose; calcareous.

The texture of the surface layer ranges from loamy sand to sandy loam. The GB horizon varies considerably in thickness and in depth.

The Ronald soils are similar to Epoufette soils in drainage, but their GB horizon occurs at a shallower depth than that of the Epoufette soils, and is thicker and finer textured. In the Ronald soils the texture of the GB horizon ranges from a fine sandy loam to sandy clay loam.

In spring, the water table of the Ronald and Epoufette soils is at or near the surface. When the water table is low, permeability is rapid.

Epoufette and Ronald soils are mainly in permanent pasture or farm woodlots. Some hay and small grain are grown. Some areas are sources for sand and gravel, but excavation is sometimes hindered by the high water table. If these soils are used for crops, drainage is the main problem. Tile generally is not satisfactory, because sand flows into it, and because it is difficult to maintain the grade in the tile lines. These soils have a moderate to moderately low moisture-holding capacity. Their supply of plant nutrients is moderate to low.

MAPPING UNITS

EeA0 Epoufette and Ronald sandy loams, 0 to 2 percent slopes. Soil management unit 4cA(IIIW).

EeB1 Epoufette and Ronald sandy loams, 2 to 6 percent slopes, slightly eroded. Soil management unit 4cB(IIIW).

Gagetown Series

The Gagetown soils were developed on stratified, calcareous silts, very fine sands, and fine sands in which there are some thin lenses of clay. These soils are generally in relatively long areas between the nearly level Sanilac soils and natural drainageways. The native vegetation consisted of sugar maple, beech, basswood, elm, and a few white pine.

Gagetown soils are the moderately well drained member of the natural toposequence that includes the imperfectly drained Sanilac soils and the poorly and very poorly drained Bach soils. The Gagetown soils are calcareous at or within 10 inches of the surface.

Profile description of a Gagetown silt loam:

A_p 0 to 9 inches; silt loam; very dark gray to very dark grayish brown (10YR 3/1 to 3/2, moist); weak, fine, granular structure; friable when moist and soft when dry; neutral to mildly alkaline; 6 to 9 inches thick.

B_{2h} 9 to 17 inches; silt loam; brown (10YR 5/3, moist); weak, coarse, granular to weak, moderate, subangular blocky structure; friable when moist; calcareous; 6 to 12 inches thick.

C_{1g} 17 to 42 inches; silt loam; light yellowish brown (2.5Y 6/4, moist), mottled with yellowish brown (10YR 5/4, moist); stratified; very friable when moist; calcareous; 20 to 30 inches thick.

C_2 42 inches+; silt and very fine sand with lenses of fine sand and clay; dark brown to brown (10YR 4/3, moist); stratified; calcareous.

The calcareous material is within 10 inches of the surface. The texture of the surface soil ranges from very fine sandy loam to silt loam. Runoff is adequate and internal drainage is medium.

Because they are moderately to strongly sloping, Gagetown soils are used mostly for pasture.

MAPPING UNITS

GaC1 Gagetown silt loam, 6 to 12 percent slopes, slightly eroded. Soil management unit 2aC(IIIE).

GaC2 Gagetown silt loam, 6 to 12 percent slopes, moderately eroded. Soil management unit 2aC(IIIE).

GaD2 Gagetown silt loam, 12 to 18 percent slopes, moderately eroded. This soil is on strongly sloping breaks between the nearly level Sanilac soils and the natural drainageways. Soil management unit 2aD(IVE).

Gladwin and Palo Series

Gladwin soils and Palo soils are mapped together in Sanilac County as undifferentiated soils. These soils are imperfectly drained. They were developed on calcareous, stratified sand and gravel. They generally occur on long, narrow ridges that roughly parallel the shoreline of Lake Huron. These ridges were formerly the shoreline of old, glacial lakes. The native vegetation was mostly sugar maple, ash, elm, beech, and white pine. The second growth is mostly aspen.

These soils are generally associated with the lighter colored, well-drained Mancelona and Newaygo soils and the dark-colored, poorly drained Epoufette and Ronald soils.

Profile description of a Gladwin sandy loam:

A_p 0 to 7 inches; sandy loam; very dark grayish brown (10YR 3/2, moist); weak, fine, granular structure; very friable when moist and soft when dry; medium in organic matter; slightly acid to neutral; 6 to 10 inches thick.

B_{2hg} 7 to 12 inches; loamy sand; light yellowish brown (10YR 6/4, moist), with brownish-yellow (10 YR 6/8, moist) streaks and splotches; very weak, thin, platy structure; very friable when moist and slightly coherent when dry; slightly to medium acid; 4 to 8 inches thick.

A_{2g} 12 to 28 inches; sand; light brownish gray (10YR 6/2, moist), with light gray and yellow (10YR 7/2 and 7/8, moist) streaks and splotches; single grain (structureless); loose; medium to slightly acid; 6 to 18 inches thick.

B_{2tg} 28 to 36 inches; gravelly sandy loam to fine sandy loam; yellowish brown (10YR 5/4 or 5/6, moist), mottled with brownish yellow and light gray (10YR 6/8, 6/6, and 7/2, moist); friable when moist and firm when dry; slightly acid to mildly alkaline; 2 to 10 inches thick.

D_g 36 inches+; sand and gravel; light gray (10YR 7/2, moist), mottled with brownish yellow and yellowish brown (10YR 6/6 and 5/8, moist); stratified; loose; calcareous.

The texture of the surface layer ranges from loamy sand to sandy loam. The B_{2tg} horizon varies from place to place in depth, thickness, and content of clay.

Profile description of a Palo sandy loam:

A_p 0 to 7 inches; sandy loam; very dark gray to dark grayish brown (10YR 3/1 to 4/2, moist); contains some gravel; moderate, fine, granular structure; friable when moist and soft when dry; slightly acid; 5 to 9 inches thick.

A_{2g} 7 to 11 inches; gravelly sandy loam to loam; grayish brown, light brownish gray, or light yellowish brown (10YR 5/2, 6/2, or 6/4, moist), mottled with strong brown and pale yellow (7.5YR 5/6 and 2.5Y 7/4, moist); moderate, coarse, granular structure to weak, thin, platy structure; friable to very friable when moist and soft when dry; medium to slightly acid; 3 to 5 inches thick.

B_{2hg} 11 to 14 inches; gravelly sandy loam; dark grayish brown to pale brown (2.5Y 4/2 to 10YR 6/3, moist), mottled with strong brown and brown (7.5YR 5/6 and 5/4, moist); moderate to strong, medium, subangular blocky structure; slightly sticky when wet, friable when moist, and hard when dry; medium acid to neutral; 3 to 6 inches thick.

B_{2tg} 14 to 27 inches; gravelly fine sandy loam to sandy clay loam; grayish brown, yellowish brown, or light yellowish brown (10YR 5/2, 5/4, or 6/4, moist), mottled with strong brown (7.5YR 5/6, moist); strong, medium, subangular blocky structure; plastic when wet, firm when moist, and hard when dry; slightly acid to neutral; 10 to 20 inches thick.

C_g 27 to 35 inches; gravelly sandy loam; light olive brown, brownish yellow, or light gray (2.5Y 5/4, 10YR 6/6, or 7/2, moist), mottled with strong brown and dark brown or brown (7.5YR 5/6 and 4/4, moist); weak, medium, subangular blocky structure; friable when moist and soft when dry; calcareous; 6 to 15 inches thick.

D 35 inches+; gravel and sand; pale brown to gray (10YR 6/3 to 5/1, moist); stratified; single grain (structureless); loose; calcareous.

The texture of the C_g horizon ranges from loamy sand to loam. The depth to the D horizon ranges from 18 to 42 inches. Throughout the profile, the amount of gravel varies considerably. The reaction of the A and B horizons ranges from medium acid to neutral.

Cleared areas of Gladwin and Palo soils are mostly in hay and permanent pasture. Much of the acreage is in second-growth forest. Many of the old beach ridges are a source for gravel that is used to surface roads.

MAPPING UNITS

GbA0 Gladwin and Palo sandy loams, 0 to 2 percent slopes. Soil management unit 4bA(IIIW).

GbB1 Gladwin and Palo sandy loams, 2 to 7 percent slopes, slightly eroded. Soil management unit 4bB(IIIW).

Gravel Pit

Gravel pits are widely distributed throughout the county. The original profiles have been destroyed by the removal of sand and gravel.

MAPPING UNIT

Gc Gravel pit. Soil management group S(VIIIS).

Greenwood Series

The Greenwood series consists almost entirely of extremely acid, fibrous peat in broad, low depressions and old lakebeds. The organic matter is the residue of sedges, mosses, and other nonwoody plants. It is more than 42 inches deep. This peat occurs in the central part of the swamp in Minden Township. It has very poor natural drainage, and the water table is at or near the surface most of the time.

The native vegetation is mostly leatherleaf, sedges, and sphagnum and hypnum mosses but includes some scattered shrubs and dwarfed trees, mainly tamarack. Sphagnum moss and other mosses flourish under the leatherleaf, which grows to a fairly uniform height over the entire bog.

Greenwood peat, which is mostly fibrous, differs from Spalding peat and Rifle peat in nature of the organic material. The Spalding peat is woody and fibrous, and the Rifle peat is less acid and more woody in the upper 12 inches.

Profile description of a Greenwood peat:

01 0 to 10 inches; mixed living and dead sphagnum mosses; very dark gray to yellowish brown (10YR 3/1 to 5/4, moist); fibrous; extremely acid; 10 to 12 inches thick.

02 10 to 30 inches; undecomposed fibrous peat; brown to yellowish brown (10YR 5/3 to 5/6, moist); spongy and feltlike; extremely acid; 10 to 24 inches thick.

03 30 inches+; fibrous peat; light brown to yellowish brown (7.5YR 6/4 to 10YR 5/6, moist); very slightly decomposed; extremely acid.

Greenwood peat ranges from 42 inches to as much as 30 feet in depth.

Greenwood peat serves as a habitat for wildlife and is probably best for that purpose. The trees have little or no commercial value. Because the organic materials are mostly undecomposed and are extremely acid, and because the water table is high, Greenwood peat probably has little value for agriculture. It is a potential source of commercial acid peat.

MAPPING UNIT

GdA0 Greenwood peat, 0 to 2 percent slopes. Soil management unit Mc-a(VIIIW).

Guelph Series

Guelph soils were developed from loam to coarse clay loam, calcareous glacial till. They are the well-drained member of the natural toposequence that includes the imperfectly drained London soils and the poorly and very poorly drained Parkhill soils (fig. 3). The native vegetation consisted mainly of sugar maple and beech but included some oak, hickory, and basswood.

***Figure 3.*—Guelph and Parkhill soils in the Port Huron moraine. Guelph soils are on the undulating uplands. Parkhill soils are in the depressions and natural drainageways.**

The Guelph soils are less acid than the Marlette soils and are leached free of carbonates to depths of only 15 to 25 inches; the Marlette soils, in contrast, are leached to depths of 25 to 40 inches.

Profile description of a Guelph loam:

A_1 0 to 3 inches; loam; dark grayish brown to very dark gray (10YR 4/2 to 3/1, moist); moderate, fine, granular structure; friable when moist and soft when dry; medium in organic matter; slightly acid to neutral; ½ to 3 inches thick.

A_2 3 to 5 inches; loam to sandy loam; dark grayish brown to light brownish gray (10YR 4/2 to 6/2, moist); weak, fine, subangular blocky structure; friable when moist and soft when dry; slightly acid to neutral; 1 to 3 inches thick.

B_{2h} 5 to 8 inches; loam to silt loam; grayish brown, brown, or dark brown (10YR 5/2 to 4/3, moist); moderate, medium, subangular blocky structure; friable to firm when moist and soft when dry; medium to slightly acid; 2 to 4 inches thick.

A_2 8 to 11 inches; loam; brown, dark brown, or pale brown (10YR 4/3 to 6/3, moist); moderate, medium, subangular blocky structure; friable when moist and soft when dry; medium to slightly acid; 2 to 4 inches thick.

B_{2t} 11 to 20 inches; clay loam to silty clay loam; brown to dark brown (10YR 4/3 to 5/3, 7.5YR 4/4 to 5/4, moist); moderate, medium, subangular blocky structure; firm when moist and hard when dry; slightly acid to neutral; 5 to 10 inches thick.

C_2 20 inches+; loam; brown (10YR 5/3, moist); weak, medium, subangular blocky structure; firm when moist and hard when dry; calcareous.

The B_{2h} horizon is distinct in wooded areas but is commonly missing in cultivated fields. Plowing has mixed the A_1, A_2, and part of the B_{2h} horizons in most places. The plow layer ranges from sandy loam to silt loam in texture. Runoff on soils that have similar cover of vegetation is medium on the gentle to moderate slopes and is rapid on the strong to steep slopes. If unprotected by a plant cover, the steep slopes have a severe hazard of water erosion. Organic matter and fertility are difficult to maintain in these soils.

More than 90 percent of the acreage in Guelph soils is used for rotation crops. The crops commonly grown are corn, wheat, oats, barley, field beans, sugar beets, and alfalfa (fig. 4).

MAPPING UNITS

GeA1 Guelph loam, 0 to 2 percent slopes, slightly eroded. Soil management unit 2aA(I).

GeB1 Guelph loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2aB(IIE).

GeB2 Guelph loam, 2 to 6 percent slopes, moderately eroded. This soil has had the B_{2t} horizon mixed into the plow layer in places. Soil management unit 2aB(IIE).

GeC1 Guelph loam, 6 to 12 percent slopes, slightly eroded. Soil management unit 2aC(IIIE).

GeC2 Guelph loam, 6 to 12 percent slopes, moderately eroded. The texture of the plow layer ranges from loam to clay loam. Soil management unit 2aC(IIIE).

GeC3 Guelph loam, 6 to 12 percent slopes, severely eroded. The texture of the surface layer ranges from loam to clay loam. Small gullies are common. This soil is generally less productive than less severely eroded Guelph loams on slopes of 6 to 12 percent. Soil management unit 2aC(IVE).

GeD1 Guelph loam, 12 to 18 percent slopes, slightly eroded. Soil management unit 2aD(IVE).

GeD2 Guelph loam, 12 to 18 percent slopes, moderately eroded. Soil management unit 2aD(IVE).

GeD3 Guelph loam, 12 to 18 percent slopes, severely eroded. The plow layer consists largely of the B_{2t} horizon and ranges from a fine loam to silty clay loam in texture. Soil management unit 2aD(VIE).

GfA1 Guelph loam and silt loam, 0 to 2 percent slopes, slightly eroded. Soil management unit 2aA(I).

GfA2 Guelph loam and silt loam, 0 to 2 percent slopes, moderately eroded. Soil management unit 2aB(IIE).

GfB1 Guelph loam and silt loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2aB(IIE).

GfB2 Guelph loam and silt loam, 2 to 6 percent slopes, moderately eroded. Soil management unit 2aB(IIE).

GfB3 Guelph loam and silt loam, 2 to 6 percent slopes, severely eroded. Erosion has removed the upper horizons. The plow layer consists largely of the B_{2t} horizon and ranges from loam to silty clay loam in texture. These soils are generally less productive than are the less severely eroded Guelph loams and silt loams on slopes of 2 to 6 percent. Soil management unit 2aB(IIIE).

GfC1 Guelph loam and silt loam, 6 to 12 percent slopes, slightly eroded. Soil management unit 2aC(IIIE).

GfC2 Guelph loam and silt loam, 6 to 12 percent slopes, moderately eroded. Soil management unit 2aC(IIIE).

GfC3 Guelph loam and silt loam, 6 to 12 percent slopes, severely eroded. Erosion has removed the upper horizons, and the plow layer is a fine loam to silty clay loam. These soils are generally less productive than are the less severely eroded Guelph loams and silt loams on slopes of 6 to 12 percent. Soil management unit 2aC(IVE).

***Figure 4.*—Alfalfa on Guelph loam with characteristic billowy topography of the Port Huron moraine.**

Figure 5.—A severely eroded area of Guelph loam on 12 to 18 percent slopes.

Figure 6.—Permanent pasture on Guelph loam and silt loam, 18+ percent slopes, slightly eroded, on the lake plain east of the Port Huron moraine in Delaware Township.

GfD1 Guelph loam and silt loam, 12 to 18 percent slopes, slightly eroded. Soil management unit 2aD(IVE).

GfD2 Guelph loam and silt loam, 12 to 18 percent slopes, moderately eroded. Soil management unit 2aD(IVE).

GfD3 Guelph loam and silt loam, 12 to 18 percent slopes, severely eroded. Water erosion has removed much of the original surface layer, and the plow layer is a fine loam to silty clay loam. Productivity is less than on the less severely eroded Guelph loam and silt loams (fig. 5). Soil management unit 2aD(VIE).

GfE1 Guelph loam and silt loam, 18+ percent slopes, slightly eroded. Figure 6 shows an area of this soil and adjacent Alluvial soils. Soil management unit 2aE(VIE).

GfE2 Guelph loam and silt loam, 18+ percent slopes, moderately eroded. Soil management unit 2aE(VIE).

GfE3 Guelph loam and silt loam, 18+ percent slopes, severely eroded. Water erosion has removed much of the original surface layer, and the plow layer is a fine loam to silty clay loam. Soil management unit 2aE(VIE).

Houghton Series

Houghton soils were developed from organic deposits more than 42 inches deep. These deposits contain little or no woody material and are in poorly and very poorly drained depressions. The native marsh vegetation consisted mostly of sedges and grasses but included some scattered shrubs and trees. Most of the acreage is along large natural drainageways, but some is in a few isolated depressions within areas of greater relief.

Houghton soils were developed on peaty material that was derived from reeds and sedges, whereas the Carlisle soils developed on mixed woody and fibrous materials. The Houghton soils are less acid than Greenwood soils, which were developed on light-brown to yellowish-brown, raw, fibrous peat.

Profile description of Houghton muck:

01 0 to 10 inches; muck; very dark brown to black (10YR 2/2 to 2/1, moist); moderately disintegrated residue from grasses and sedges; moderate, fine, granular structure; strongly acid to neutral; 8 to 12 inches thick.

02 10 to 30 inches; fibrous muck; very dark brown to dark grayish brown (10YR 2/2 to 4/2, moist); grades into peat; medium to slightly acid; 16 to 24 inches thick.

03 30 inches+; fibrous peat; yellowish brown to dark yellowish brown (10YR 5/8 to 4/4, moist); largely reeds and sedges; massive (structureless); slightly acid to neutral.

The horizons vary in degree of decomposition of the organic materials. In wet periods the water table is at or near the surface.

Houghton muck is used mostly for special crops and pasture. Marsh hay is cut in some places.

MAPPING UNIT

HaA0 Houghton muck, 0 to 2 percent slopes. Soil management unit Mc(IIIW).

Houghton and Palms Series

Houghton soils and Palms soils are mapped together as undifferentiated soils. These soils are mucks that were developed from fibrous peat containing little or no woody material. They are generally in poorly to very poorly drained depressions and along large natural drainageways. The water table is at or near the surface in wet periods. Houghton soils have an organic layer more than 42 inches deep; Palms soils have an organic layer 12 to 42 inches thick that is underlain by medium-textured mineral material. The native vegetation on these soils was mostly sedges and grasses but included some scattered shrubs and trees.

Carlisle and Linwood mucks were developed from mixed woody, grassy, and sedgy materials; Houghton and Palms mucks were developed from reedy and sedgy organic materials.

A profile of a Houghton muck is described under the heading, Houghton Series.

Profile description of Palms muck:

01 0 to 10 inches; muck; very dark brown to black (10YR 2/2 to 2/1, moist); well decomposed; derived from grasses and sedges; moderate, fine to medium, granular structure; friable when moist and slightly hard when dry; strongly acid to neutral; 8 to 12 inches thick.

02 10 to 25 inches; muck or fibrous peat; very dark brown to dark grayish brown (10YR 2/2 to 4/2, moist); well to moderately well decomposed; slightly acid; 4 to 30 inches thick.

03 25 to 30 inches; gelatinous sedimentary peat; gray, light gray, or light yellowish brown (10YR 6/1 or 6/4, moist); slightly acid; 3 to 6 inches thick.

D 30 inches+; loam; olive, gray, light gray, or light yellowish brown (5Y 5/3, 10YR 6/1, or 6/4, moist); massive

Figure 7.—**Sugar beets on Houghton and Palms mucks. Windbreaks around the field to prevent erosion.**

(structureless); appears to be stratified in many places; sticky when wet and friable to firm when moist; calcareous.

In wet seasons the water table is at or near the surface.

About half the acreage of this unit is drained and used for cultivated crops (fig. 7). Use for crops is limited, however, because these soils are difficult and costly to drain, deficient in plant nutrients, and susceptible to wind erosion and to damage by frost.

MAPPING UNIT

HbA0 Houghton and Palms mucks, 0 to 2 percent slopes. Soil management unit Mc(IIIW).

Huron Series

Huron soils were developed from gray to yellowish-brown, clay loam to silty clay loam, calcareous till. They are gently to strongly sloping and well to moderately well drained. The native vegetation was mainly sugar maple, beech, elm, basswood, and hickory.

These soils are in the natural toposequence that includes the imperfectly drained Perth soils and the poorly to very poorly drained Sims soils. Huron soils are finer textured than Guelph soils, which developed on loam parent material.

Profile description of Huron silt loam:

A_1 0 to 3 inches; silt loam; dark grayish brown to black (2.5Y 4/2 to 10YR 2/1, moist); moderate, fine, granular structure; friable when moist and soft when dry; neutral to medium acid; 1 to 3 inches thick.

A_2 3 to 6 inches; loam; light gray to very pale brown (10YR 7/2 to 7/3, moist); weak, fine, granular structure; friable when moist and soft when dry; medium to slightly acid; 2 to 4 inches thick.

B_{2h} 6 to 9 inches; loam to sandy loam; pale brown to brown (10YR 6/3 to 5/3, moist); moderate, fine, granular structure to moderate, medium, subangular blocky structure; friable when moist and soft when dry; strongly to medium acid; 2 to 4 inches thick.

A_2 9 to 12 inches; loam; pale brown to light brownish gray (10YR 6/3 to 2.5Y 6/2, moist); moderate to strong, medium, subangular blocky structure; slightly plastic when wet, firm when moist, and hard when dry; strongly acid; 2 to 4 inches thick.

B_{2t} 12 to 24 inches; silty clay loam to fine silty clay loam; light olive brown (2.5Y 5/4, moist); strong, medium, subangular blocky structure to strong, coarse, blocky structure; plastic when wet, very firm when moist, and very hard when dry; slightly acid to neutral; 8 to 12 inches thick.

C 24 inches+; silty clay loam to clay loam till; light olive brown to grayish brown (2.5Y 5/4 to 5/2, moist); moderate, medium, angular blocky to subangular blocky structure; plastic when wet, firm when moist, and hard when dry; calcareous.

The texture of the surface layer ranges from a loam to coarse silty clay loam. Where there is little or no erosion, the plow layer is very dark gray to dark grayish brown. The depth to the calcareous till varies from 18 to 35 inches.

Most of the Huron soil has been cleared and is used for rotation crops. If plowed when too wet, clods form when it dries and the soil is difficult to work. Water erosion is active on cultivated slopes.

MAPPING UNIT

HcB1 Huron silt loam, 2 to 6 percent slopes, slightly eroded. Included with this soil are some small areas that have slopes of more than 6 percent and that are more than slightly eroded. Soil management unit 2aB(IIE).

Iosco and Croswell Series

Iosco sandy loams and Croswell loamy sands are so closely associated in Sanilac County that they are mapped together. The Iosco soils are imperfectly drained, and the Croswell soils are moderately well drained. Iosco soils were developed from sands or loamy sands that are 18 to 42 inches deep over loam to silty clay loam calcareous till. Croswell soils were developed in loose, deep sands. The native vegetation was mostly sugar maple, beech, elm, ash, and basswood but included some white pine. A representative profile of a Croswell loamy sand is described under the heading, Croswell Series.

Iosco soils are the imperfectly drained member of the natural toposequence that includes the well to moderately well drained Menominee soils.

Profile description of an Iosco sandy loam:

A_p 0 to 6 inches; sandy loam; very dark brown, very dark gray, or very dark grayish brown (10YR 2/2, 3/1, or 3/2, moist); weak, fine, granular structure; friable when moist and soft when dry; medium to high in organic matter; medium acid to neutral in reaction; 6 to 10 inches thick.

A_2 6 to 8 inches; sand; light gray, pinkish gray, or brown (5YR 7/1, 7.5YR 7/2, or 10YR 5/3, moist); single grain (structureless); loose; slightly to strongly acid; 1 to 8 inches thick.

B_{21hg} 8 to 15 inches; sand; yellowish red, reddish yellow, brown, dark brown, or yellowish brown (5YR 5/6, 7.5YR 7/6, or 4/2, 10YR 5/4, or 5/6, moist), mottled with strong brown (7.5YR 5/6, moist); single grain (structureless); loose to slightly cemented; slightly to strongly acid; 2 to 8 inches thick.

B_{22hg} 15 to 25 inches; sand; reddish yellow, very pale brown, grayish brown, or yellowish brown (7.5YR 6/6, 10YR 7/3, 5/2, or 5/4, moist), mottled with strong brown (7.5YR 5/6, moist); single grain (structureless); loose; medium to slightly acid; 6 to 12 inches thick.

B_{3hg} 25 to 30 inches; sand; strong brown (7.5YR 5/6, moist), mottled with brown and dark brown (7.5YR 4/4, moist); single grain (structureless); loose; medium acid; 4 to 8 inches thick.

C_1 30 to 36 inches; sand; brown, yellowish brown, grayish brown, or very pale brown (7.5YR 5/4, 10YR 5/4, 5/2, or 7/3, moist); single grain (structureless); loose; medium acid to neutral; 2 to 8 inches thick.

D 36 inches+; loam to silty clay loam; light brownish gray, brown, or light olive brown (10YR 6/2, 5/3, or 2.5Y 5/4, moist); massive (structureless); plastic when wet and firm when moist; calcareous.

The thickness of the individual horizons varies according to the thickness of the coarser textured part of the profile. In many areas the B_3 and C_1 horizons have lenses of fine-textured materials.

Iosco sandy loams and Croswell loamy sands are generally used for crops grown in rotation, mainly corn, wheat, oats, dry beans, and legume-grass mixtures. Yields, however, are only fair because these soils are low in moisture-holding capacity and in plant nutrients. About 20 to 30 percent of the acreage is in permanent pasture or farm woodlots.

MAPPING UNITS

IcA0 Iosco sandy loam and Croswell loamy sand, 0 to 2 percent slopes. Soil management unit 4bA(IIIW).
IcB1 Iosco sandy loam and Croswell loamy sand, 2 to 7 percent slopes, slightly eroded. Soil management unit 4bB(IIIW).
IcC1 Iosco sandy loam and Croswell loamy sand, 7 to 14 percent slopes, slightly eroded. Soil management unit 4aC(IIIS).
IcD1 Iosco sandy loam and Croswell loamy sand, 14+ percent slopes, slightly eroded. Soil management unit 4aD(IVS).

Iosco and Menominee Series

Iosco loamy sands and Menominee loamy sands are so closely associated in Sanilac County that they were mapped together. These soils were developed from sands or loamy sands that are 18 to 42 inches deep over calcareous loam to silty clay loam glacial till. The native vegetation was mainly hardwoods and conifers.

Menominee soils are the well to moderately well drained member and Iosco soils are the imperfectly drained member of a natural toposequence.

A profile of an Iosco soil is described under the heading, Iosco and Croswell Series.

Profile description of a Menominee loamy sand:

A_p 0 to 7 inches; loamy sand; very dark brown to very dark grayish brown (10YR 2/2 to 3/2, moist); very weak, fine, granular structure; very friable when moist and soft when dry; medium acid to neutral; 6 to 10 inches thick.

B_{21h} 7 to 14 inches; sand; yellowish brown, brown, or dark brown (10YR 5/4 or 7.5YR 4/4, moist); weakly cemented to loose; medium acid to slightly acid; 4 to 8 inches thick.

B_{22h} 14 to 29 inches; sand; reddish yellow, brown, or dark brown (7.5YR 6/6 or 10YR 4/3, moist); single grain (structureless); loose; slightly acid; 10 to 15 inches thick.

C_1 29 to 39 inches; sand; light yellowish brown (10YR 6/4, moist); single grain (structureless); slightly acid to calcareous; 2 to 20 inches thick.

D 39 inches+; loam to silty clay loam till; pale brown to light yellowish brown (10YR 6/3 to 6/4, moist); massive (structureless); plastic when wet and firm when moist; calcareous.

The depth to the D horizon generally ranges from 18 to 42 inches, but in some areas it is deeper. This variation causes a variation in thickness of the upper horizons. In a few places, the sandy layers contain lenses of finer textured material. Runoff is slow and, in the upper horizons, permeability is rapid.

Most areas of Iosco and Menominee soils have been cleared and are used mainly for corn, oats, wheat, dry beans, and alfalfa. Because these soils are only fair to medium in moisture-holding capacity, most crops are injured by drought in periods of low rainfall.

MAPPING UNITS

IaA0 Iosco amd Menominee loamy sands, 0 to 2 percent slopes. Soil management unit 4bA(IIIW).
IaB1 Iosco and Menominee loamy sands, 2 to 6 percent slopes, slightly eroded. Soil management unit 4bB(IIIW).

Iosco and Winegars Series

Iosco sandy loams and Winegars sandy loams are mapped together in Sanilac County. These soils are imperfectly drained. The Iosco soils were developed from sand and loamy sand that is 18 to 42 inches deep over calcareous loam to silty clay loam till. The Winegars soils were developed on sandy and gravelly material that is 42 to 66 inches deep over loam to clay till. The native vegetation on these soils was mainly elm, ash, sugar maple, and beech but included some scattered white pine.

A profile of Iosco sandy loam is described under the heading, Iosco and Croswell Series.

Profile description of a Winegars sandy loam:

A_p 0 to 7 inches; sandy loam; very dark brown, very dark grayish brown, or dark gray (10YR 2/2, 3/2, or 4/1, moist); weak, fine, granular structure; very friable when moist and soft when dry; medium to high in organic matter; medium acid to neutral; 6 to 9 inches thick.

B_{2h} 7 to 10 inches; loamy sand; brown to grayish brown (10YR 5/3 to 5/2, moist); weak, fine, granular structure to weak, thin, platy structure; very friable when moist and slightly hard when dry; slightly acid; 3 to 6 inches thick.

A_2 10 to 15 inches; loamy sand; yellowish brown, grayish brown, or pinkish gray (10YR 5/4, 5/2, or 7.5YR 7/2, moist); very weak, fine, granular structure to single grain (structureless); very friable to loose when moist and slightly coherent when dry; medium to slightly acid; 2 to 8 inches thick.

B_{1tg} 15 to 43 inches; gravelly sand to loamy sand; dark yellowish brown (10YR 4/4, moist), mottled with pale brown and very pale brown (10YR 6/3 and 7/3, moist); very weak, medium, granular structure to single grain (structureless); loose to very slightly coherent; medium to slightly acid; 15 to 40 inches thick.

B_{2t} 43 to 47 inches; gravelly fine sandy loam to coarse sandy clay loam; dark brown to brown (7.5YR 4/4, moist); weak, medium, subangular blocky structure; friable when moist and slightly hard when dry; slightly acid to mildly alkaline; 2 to 10 inches thick.

C_g 47 to 54 inches; coarse sand and gravel; brown (10YR 5/3, moist), mottled with yellowish brown and brownish yellow (10YR 5/6 and 6/6, moist); stratified; single grain (structureless); loose; calcareous; 3 to 15 inches thick.

D 54 inches+; loam to clay; pale brown to yellowish brown (10YR 6/3 to 5/6, moist); massive (structureless); sticky when wet, firm when moist, and hard when dry; calcareous.

The depth to the fine-textured D horizon varies between 42 and 66 inches. Gravel occurs throughout the upper coarse-textured horizons.

More than three-fourths of the acreage of Iosco and Winegars soils is cleared and is used mainly for corn, wheat, oats, field beans, sugar beets, and hay. The rest is in permanent pasture or in second-growth forest.

MAPPING UNITS

IbA0 Iosco and Winegars sandy loams, 0 to 2 percent slopes. Soil management unit 4bA(IIIW).

IbB1 Iosco and Winegars sandy loams, 2 to 6 percent slopes, slightly eroded. Soil management unit 4bB(IIIW).

Jeddo Series

This series consists of poorly drained to very poorly drained soils that are on level plains or in depressions. These soils were developed from calcareous clay loam or silty clay loam glacial till that contains a fairly large amount of shale. The substratum contains many shale fragments. The native vegetation was mostly elm, ash, swamp white oak, red maple, and basswood.

Jeddo soils are more acid in the surface layer and subsoil than the poorly to very poorly drained Sims and Parkhill soils. They are also finer textured throughout the subsoil and substratum than the Parkhill soils.

Profile description of Jeddo silty clay loam:

A_p 0 to 7 inches; silty clay loam; very dark gray to grayish brown (10YR 3/1 to 2.5Y 5/2, moist); moderate, medium, granular structure; plastic when wet, firm when moist, and hard when dry; medium acid to neutral; 6 to 8 inches thick.

GA 7 to 12 inches; silty clay loam to sandy clay loam; grayish brown to light brownish gray (2.5Y 5/2 to 6/2, moist), mottled with olive to strong brown (5Y 4/4 to 7.5YR 5/6, moist); strong, coarse, granular structure to moderate, fine, subangular blocky structure; plastic when wet, firm when moist, and hard when dry; medium to strongly acid; 4 to 7 inches thick.

GB_1 12 to 15 inches; clay loam to silty clay loam; gray to light gray (5Y 5/1 to 10YR 7/1, moist), mottled with olive and yellowish brown (5Y 4/4 and 10YR 5/6, moist); strong, fine, angular blocky structure; plastic when wet, firm when moist, and hard when dry; medium to strongly acid; 3 to 5 inches thick.

GB_2 15 to 25 inches; silty clay loam; grayish brown to brown (2.5Y 5/2 to 7.5YR 5/4, moist), mottled with yellowish brown, gray, and light gray (10YR 5/6 and 6/1, moist); moderate, medium, angular blocky structure; plastic when wet, firm when moist, and hard when dry; medium to slightly acid; 7 to 12 inches thick.

GB_3 25 to 36 inches; silty clay loam; gray, yellowish brown, or olive brown (5Y 5/1, 10YR 5/4, or 2.5Y 4/4, moist), mottled with gray and light gray (5Y 5/1 and 10YR 6/1, moist); strong, medium to coarse, angular blocky structure; plastic when wet, firm when moist, and very hard when dry; slightly acid to neutral; 8 to 12 inches thick.

C_g 36 inches+; silty clay loam to clay loam; yellowish brown (10YR 5/4 and 5/8, moist), mottled with gray and light gray (5Y 5/1 and 10YR 6/1, moist); moderate, coarse, angular blocky structure; plastic when wet, firm when moist, and very hard when dry; calcareous.

The color of the plow layer varies from very dark gray to grayish brown. Fine-textured, calcareous parent material occurs at depths ranging from 36 to 56 inches. The GB horizons may have almost no bright colors or may have as much as 35 percent of the material brightly colored. Runoff is very slow to ponded. Internal drainage is slow to very slow.

Where adequately drained, Jeddo soils are used mainly for corn, oats, dry beans, sugar beets, and hay. Some areas are in permanent pasture or farm woodlots. Because most of the wooded areas are grazed, they are not used to their capacity for producing timber.

MAPPING UNIT

JoA0 Jeddo silty clay loam, 0 to 2 percent slopes. Soil management unit 2cA(IIW).

Kalkaska and Wallace Series

The Kalkaska soils and the Wallace soils are mapped together in Sanilac County as undifferentiated soils. These soils were formed on old beach ridges, old sand dunes, and glacial outwash plains. They are well drained and were developed from sands of mixed mineral composition. The native vegetation was mainly white pine and red pine, and the second growth is mostly aspen and sumac. Many areas now have only a sparse cover of grass.

The Wallace soils, except for their very strongly cemented B_h horizon, are similar to the Kalkaska soils. This strongly cemented horizon interferes with the movement of water and the development of root systems.

The subsoil of the Kalkaska and Wallace soils is more strongly developed than that of the Rubicon soils, which were also developed on sands.

Profile description of a Kalkaska fine sand:

A_p 0 to 8 inches; fine sand; dark grayish brown to yellowish brown (10YR 4/2 to 5/4, moist); very weak, fine, granular structure; very friable when moist; medium acid to neutral; 6 to 10 inches thick.

A_2 8 to 11 inches; fine to medium sand; brown to pinkish gray (7.5YR 5/2 to 6/2, moist); single grain (structureless); loose; medium acid; 3 to 8 inches thick.

B_{21h} 11 to 13 inches; loamy sand; dark reddish brown (5YR 3/4, 3/3 to 3/2, moist); weak, fine, granular structure; weakly cemented in places; strongly to medium acid; 1 to 6 inches thick.

B_{22h} 13 to 20 inches; loamy sand; yellowish red (5YR 5/8, moist); very weak, fine, granular structure to single grain (structureless); weakly cemented in places; strongly acid to medium acid; 5 to 10 inches thick.

C_1 20 inches+; fine to medium sand; yellowish brown to brownish yellow (10YR 5/6 to 6/6, moist); single grain (structureless); loose; slightly to medium acid.

Tongues of the iron and humus subsoil extend into the lower horizons. The subsoil ranges from very weakly to strongly cemented. Calcareous sand occurs in some places at a depth of about 84 inches. Runoff is slow and permeability is rapid.

Most of the acreage in Kalkaska and Wallace soils is cut over and now supports only a sparse growth of trees. Many of these areas are used for pasture. Areas that were once cleared and farmed are now idle or are used for limited grazing. The few crops that are grown have poor yields.

MAPPING UNITS

KaA1 Kalkaska and Wallace fine sands, 0 to 2 percent slopes, slightly eroded. Soil management unit 5aA(IVS).

KaB1 Kalkaska and Wallace fine sands, 2 to 8 percent slopes, slightly eroded. In many places these soils have a strongly cemented subsoil. Soil management unit 5aB(IVS).

KaC1 Kalkaska and Wallace fine sands, 8 to 18 percent slopes, slightly eroded. In many places these soils have a strongly cemented subsoil. Soil management unit 5aD(VIIS).

Kerston Series

Kerston muck consists of alternate layers of organic materials and alluvial sand or silt. The layers of mineral materials are generally thinner than the layers of muck. Kerston muck occupies very poorly drained former stream bottoms or depressions through which streams now flow. Because this soil gradually merges with the alluvial lands in many places, it cannot always be sharply delineated. The native vegetation was mainly alder and willow but included some elm, ash, ironwood, red maple, and conifers.

Figure 8.—Sandy beach along Lake Huron.

Profile description of Kerston muck:

01 0 to 8 inches; muck; very dark gray or black (10YR 3/1 to 2/1, moist); weak, fine, granular structure; friable when moist and slightly hard when dry; slightly acid to mildly alkaline; 6 to 15 inches thick.

0 and D 8 inches+, alternating layers of black to dark-brown or brown (10YR 2/1 to 4/3, moist) muck and gray (10YR 5/1, moist) sand to silt; stratified; slightly acid to calcareous.

Within short distances, the thickness of the surface layer and the thickness and sequence of the other horizons vary.

Because Kerston muck is in irregularly shaped areas, is poorly drained, and is susceptible to crop damage by frost and flood, this soil can be used only for pasture and trees. Trees, however, are seldom planted.

MAPPING UNIT

KbA0 Kerston muck, 0 to 2 percent slopes. Soil management unit L3c(VW).

Lake Beach, Sandy

This miscellaneous land type is the sandy, wave-washed beach along the shore of Lake Huron (fig. 8). It is affected by seasonal and yearly changes in the water level of Lake Huron.

MAPPING UNIT

La Lake beach, sandy. Soil management group S(VIIIS).

Lake Beach, Rocky

This miscellaneous land type consists of wave-washed beach along the shore of Lake Huron. It is essentially a pavement of cobblestones, stones, and boulders. Rock crops out in a few places. The size of areas of this land type changes as the water level of Lake Huron fluctuates.

MAPPING UNIT

Lb Lake beach, rocky. Soil management group S(VIIIS).

Lake Beach, Stony

This miscellaneous land type consists of stony beach along Lake Huron. It contains enough boulders, stones, slabs, cobblestones, and gravel to limit its use for recreation. Rock crops out in a few places.

MAPPING UNIT

Lc Lake beach, stony. Soil management group S(VIIIS).

Linwood Series

Linwood muck consists of disintegrated woody and sedgy plant materials that are 12 to 42 inches deep over medium-textured mineral materials. These soils were developed in poorly to very poorly drained depressions, along natural drainageways, and in isolated depressions within areas of considerable relief. The native vegetation was mixed swamp hardwoods and conifers. In areas that have been cut over and burned, the stands are mainly alder, willow, and dogwood.

Palms muck differs from Linwood muck in having developed from fibrous plant material containing little or no woody material.

Profile description of Linwood muck:

01 0 to 15 inches; woody muck; black to very dark grayish brown (10YR 2/1 to 3/2, moist); well disintegrated; moderate, medium, granular structure; medium acid to neutral; 8 to 15 inches thick.

02 15 to 24 inches; organic material; dark brown (7.5YR 3/2, moist); fairly well disintegrated; medium acid; 8 to 15 inches thick.

03 24 to 28 inches; very dark gray (5Y 3/1, moist); macerated peat; medium acid; 2 to 6 inches thick.

D 28 inches+; loam; light brownish gray (2.5Y 6/2, moist), mottled with yellowish brown (10YR 5/6, moist); massive (structureless); slightly sticky when wet and friable to firm when moist; calcareous.

The thickness of the organic material ranges from 12 to 42 inches, and the texture of underlying mineral material ranges from sandy loam to silt loam. In wet periods the water table is at or near the surface.

Most of the acreage is in permanent pasture or farm woodlots that are grazed. Areas that are cleared and drained are used for special and field crops.

MAPPING UNIT

LdA0 Linwood muck, 0 to 2 percent slopes. Soil management unit M/3c(IIW).

Linwood and Tawas Series

Where they occur together in Sanilac County, Linwood and Tawas mucks were mapped together as undifferentiated soils. These soils were developed from woody plant materials 12 to 42 inches thick over coarse- to medium-textured materials. They generally occur in poorly to very poorly drained depressions, along the larger natural drainageways, or in isolated depressions. Linwood muck is underlain by medium-textured mineral materials, and the Tawas, by coarse-textured mineral materials. The native vegetation was mixed hardwoods and conifers. Areas that have been cut over and burned over are in alder, willow, dogwood, and other shrubs.

The Palms and the Adrian mucks differ from these soils in having developed from fibrous organic materials; these soils were developed from woody plant materials.

A profile of the Linwood muck is described under the heading, Linwood Series.

Profile description of Tawas muck:

01 0 to 12 inches; muck; black to very dark grayish brown (10YR 2/1 to 3/2, moist); some remains of woody materials; moderate, medium, granular structure; strongly acid to neutral; 10 to 15 inches thick.

02 12 to 24 inches; pulpy or woody peat; dark brown to very dark brown (7.5YR 3/2 to 10YR 2/2, moist); partly disintegrated; medium to slightly acid; 8 to 15 inches thick.

03 24 to 30 inches; woody and fibrous organic materials; very dark brown to very dark gray (10YR 2/2 to 5Y 3/1, moist); well to poorly disintegrated; medium acid to mildly alkaline; lower part is a mixture of peat and sandy materials; 4 to 12 inches thick.

D 30 inches+; sand, loamy sand, or gravelly sand; olive (5Y 5/3, moist), mottled with yellowish brown (10YR 5/4, moist); single grain (structureless); calcareous.

The thickness of the combined organic layers ranges from 12 to 42 inches, and the texture of the underlying mineral materials ranges from sands to loams. In the wet periods, the water table is at or near the surface. Most of the acreage is in permanent pasture or in woodlands that are grazed. Areas that are cleared and adequately drained are used for special and field crops.

MAPPING UNIT

LeA0 Linwood and Tawas mucks, 0 to 2 percent slopes. Soil management unit M/3c(IIW).

London Series

The London series consists of imperfectly drained soils that were developed from calcareous loam to coarse clay loam glacial till. These soils are on nearly level areas between natural drainageways, along the bases of slopes, and on slightly undulating plains. The native vegetation was sugar maple, beech, elm, ash, and basswood but included some scattered white pine.

The London soils are the imperfectly drained member of the natural toposequence that includes the poorly to very poorly drained Parkhill and Jeddo soils and the well drained to moderately well drained Guelph soils. The London soils have a darker colored surface layer than the Guelph soils and are lighter colored than the Parkhill and Jeddo soils. London soils are less acid than the Capac soils and are shallower to calcareous till. In the London soils, the limy material is at depths of 15 to 25 inches; in Capac soils, it is at depths of 25 to 45 inches.

Profile description of a London loam:

A_p 0 to 8 inches; loam; dark grayish brown to very dark gray (10YR 4/2 to 3/1, moist); weak, fine, granular structure; friable when moist and slightly hard when dry; neutral to mildly alkaline; 5 to 8 inches thick.

B_{2hg} 8 to 12 inches; loam; light yellowish brown, pale brown, or yellowish brown (10YR 6/4, 6/3, or 5/4, moist), mottled with yellowish brown (10YR 5/8, moist); weak, thin, platy structure to weak, medium, granular structure; slightly sticky when wet, friable when moist, and hard when dry; neutral to mildly alkaline; 4 to 6 inches thick.

B_{21tg} 12 to 17 inches; clay loam; brown to pale brown (10YR 5/3 to 6/3, moist), mottled with yellowish brown (10YR 5/6, moist); moderate, medium, angular blocky to subangular blocky structure; sticky when wet, firm when moist, and very hard when dry; neutral to mildly alkaline; 4 to 6 inches thick.

B_{22tg} 17 to 23 inches; loam; grayish brown to pale brown (2.5Y 5/2 to 10YR 6/3, moist), mottled with yellowish brown and dark yellowish brown (10YR 5/6 and 4/4, moist); moderate, coarse, angular blocky structure; firm when moist and very hard when dry; slightly acid to mildly alkaline; 6 to 8 inches thick.

C_g 23 inches+; loam to coarse clay loam till; light brownish gray to brown (2.5Y 6/2 to 10YR 5/3, moist), mottled with yellowish brown and brown (10YR 5/6 and 7.5YR 5/4, moist); strong, medium to very coarse, angular blocky structure; sticky when wet, firm when moist, and very hard when dry; calcareous.

***Figure 9.*—Placing tile on London loam on lake plain east of Port Huron moraine.**

The texture of the surface layer ranges from fine sandy loam to silt loam, and the depth to calcareous till varies between 15 and 25 inches. Permeability is moderate.

Most of the acreage in London soils is cleared and used for corn, wheat, oats, barley, field beans, sugar beets, and legume-grass mixtures. The rest is in permanent pasture or farm woodlots. Some of the acreage is artificially drained (fig. 9).

MAPPING UNITS

LfA0 London loam and fine sandy loam, 0 to 2 percent slopes. Soil management unit 2bA(I).

LfB1 London loam and fine sandy loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2bB(IIW).

LfB2 London loam and fine sandy loam, 2 to 6 percent slopes, moderately eroded. Water erosion has removed most of the original surface layer, and the finer textured B_{2t} horizon is exposed in the plow layer. Soil management unit 2bB(IIW).

LgA0 London loam and silt loam, 0 to 2 percent slopes. Soil management unit 2bA(I).

LgB1 London loam and silt loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2bB(IIW).

LgB2 London loam and silt loam, 2 to 6 percent slopes, moderately eroded. Soil management unit 2bB(IIW).

LgC1 London loam and silt loam, 6 to 12 percent slopes, slightly or moderately eroded. Soil management unit 2bB(IIW).

McBride Series

McBride soils are well drained and were developed from sandy loam materials that are moderate in lime. The native vegetation was mostly sugar maple and beech but included some white pine.
toposequence that includes the imperfectly drained Coral

These soils are the well drained member of the natural and the poorly to very poorly drained Ensley soils. They are finer textured than the Montcalm soils, which were developed from loamy sand materials. They are coarser textured than the Marlette soils. The Marlette soils were developed from loam materials.

Profile description of a McBride fine sandy loam:

A_1 0 to 2 inches; fine sandy loam; black to very dark grayish brown (10YR 2/1 to 3/2, moist); weak, fine, granular structure; very friable when moist and loose when dry; medium to slightly acid; ½ to 3 inches thick.

A_2 2 to 5 inches; loamy sand to fine sandy loam; brown to light gray (10YR 5/3 to 7/2, moist); very weak, fine, granular structure; very friable; strongly to very strongly acid; 1 to 4 inches thick.

B_{2h} 5 to 10 inches; sandy loam to fine sandy loam; strong brown, dark brown, or brown (7.5YR 5/6 or 10YR 4/3, moist); weak, fine to medium, granular structure; friable when moist and slightly hard when dry in most places, but weakly cemented in some places; strongly to medium acid; 3 to 6 inches thick.

A_2 10 to 16 inches; fine sand to coarse sandy loam; light yellowish brown to brownish yellow (10YR 6/4 to 6/6, moist); very weak, fine, granular structure to very weak, thin, platy structure; slightly compact fragipan; friable when moist and brittle when dry; strongly to slightly acid; 6 to 10 inches thick.

B_{2t} 16 to 30 inches; sandy loam to sandy clay loam; brown, dark brown, light yellowish brown, or reddish brown (10YR 4/3, 6/4, or 5YR 4/4, moist); weak, medium to coarse, angular blocky to subangular blocky structure; slightly sticky when wet, friable when moist, and hard when dry; slightly to medium acid; 10 to 20 inches thick.

B_3 30 to 45 inches; sandy loam; light yellowish brown or brownish yellow (10YR 6/4 or 6/8, moist); weak, medium, subangular blocky structure; friable when moist and hard when dry; slightly acid to neutral; 5 to 20 inches thick.

C 45 inches+; sandy loam; light yellowish brown to yellowish brown (10YR 6/4 to 5/6, moist); weak to moderate, medium, subangular blocky structure; friable when moist and hard when dry; neutral to calcareous.

In many places the A_2 horizons have a weak platy structure. In some places carbonates are leached to depths greater than 66 inches. The initial plowing mixes the A_1, the upper A_2, and most of the B_{2h} horizons. In areas that have similar vegetation, runoff is medium on the gentle to moderate slopes and rapid on the strong to steep slopes. The fragipan tends to retard the downward movement of water and roots.

Most of the acreage of McBride soils that has slopes of less than 12 percent is used mainly for corn, wheat, oats, dry beans, and legume-grass mixtures. The rest is in permanent pasture and farm woodlots. The steeper slopes are used for hay, permanent pasture, and woodlots.

MAPPING UNITS

MaA1 McBride fine sandy loam, 0 to 2 percent slopes, slightly eroded. Soil management unit 3aA(IIS).

MaB1 McBride fine sandy loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 3aB(IIS).

MaB2 McBride fine sandy loam, 2 to 6 percent slopes, moderately eroded. Soil management unit 3aB(IIS).

MaC1 McBride fine sandy loam, 6 to 12 percent slopes, slightly eroded. Soil management unit 3aC(IIIS).

MaC2 McBride fine sandy loam, 6 to 12 percent slopes, moderately eroded. Soil management unit 3aC(IIIS).

MaD1 McBride fine sandy loam, 12 to 18 percent slopes, slightly eroded. Soil management unit 3aD(IVS).

MaD2 McBride fine sandy loam, 12 to 18 percent slopes, moderately eroded. Erosion has removed so much material that the lighter colored lower A_2 horizon dominates in the plow layer. Soil management unit 3aD(IVS).

MaD3 McBride fine sandy loam, 12 to 18 percent slopes, severely eroded. Erosion has removed so much material that the finer textured B_{2t} horizon dominates in the plow layer. Soil management unit 3aE(VIS).

McBride and Montcalm Series

Where they occur close together in Sanilac County, the McBride sandy loams and the Montcalm loamy sands are mapped together as undifferentiated soils. Profiles of a McBride fine sandy loam and a Montcalm loamy sand are described under the heading of the respective series.

MAPPING UNITS

MbA1 McBride sandy loam and Montcalm loamy sand, 0 to 3 percent slopes, slightly eroded. Soil management unit 3aA(IIS).

MbB1 McBride sandy loam and Montcalm loamy sand, 3 to 8 percent slopes, slightly eroded. Soil management unit 3aB(IIS).

MbB3 McBride sandy loam and Montcalm loamy sand, 3 to 8 percent slopes, severely eroded. These soils are not so productive as the less eroded soils. Soil management unit 3aB(IIS).

MbC1 McBride sandy loam and Montcalm loamy sand, 8 to 15 percent slopes, slightly eroded. Soil management unit 3aC(IIIS).

MbC2 McBride sandy loam and Montcalm loamy sand, 8 to 15 percent slopes, moderately or severely eroded. Erosion has removed so much soil material that the plow layer is a mixture of the lighter colored lower A_2 horizon and the finer textured subsoil. Soil management unit 3aC(IIIS).

MbD1 McBride sandy loam and Montcalm loamy sand, 15 to 25 percent slopes, slightly eroded. Soil management unit 3aD(IVS).

MbE3 McBride sandy loam and Montcalm loamy sand, 15+ percent slopes, moderately or severely eroded. Soil management unit 3aE(VIS).

McGregor Series

This series consists of imperfectly drained soils that are on outwash plains, terraces, and old beach ridges. McGregor soils were developed on stratified deposits of calcareous sand and gravel. The native vegetation was mostly elm, ash, sugar maple, and beech but included some basswood and white pine.

McGregor soils developed from calcareous sand and gravel, as did the Palo soils. The McGregor soils, however, are calcareous at the surface and throughout the profile, whereas the Palo soils are slightly acid to neutral in the solum.

Profile description of a McGregor sandy loam:

A_p 0 to 8 inches; sandy loam; very dark brown or very dark grayish brown (10YR 2/2 or 3/2, moist); moderate, fine, granular structure; friable when moist and soft when dry; calcareous; 4 to 9 inches thick.

B_{2ht} 8 to 15 inches; gravelly sandy loam to sandy clay loam; yellowish brown (10YR 5/4 to 5/8, moist); moderate to weak, medium, subangular blocky structure; plastic when wet, friable when moist, and slightly hard when dry; calcareous; 5 to 10 inches thick.

B_{2tg} 15 to 25 inches; gravelly sandy loam to sandy clay loam; grayish brown to yellowish brown (10YR 5/2 to 5/4, moist), mottled with light yellowish brown, light brownish gray, and light olive brown (10YR 6/4, 6/2, and 2.5Y 5/4, moist); weak, medium, subangular blocky structure; friable when moist and soft when dry; calcareous; 6 to 10 inches thick.

C 25 inches+; sand and gravel; grayish brown, light gray, or pinkish gray (10YR 5/2, 7/2 or 5YR 6/2, moist); loose; stratified; calcareous.

All horizons vary considerably in their content of sand and gravel. The surface layer is neutral to calcareous. Carbonates occur at the surface or within the upper 10 inches of the profile. The water table fluctuates between depths of 2 and 6 feet.

McGregor soils are used mostly for hay and permanent pasture. Some of the undrained areas are in farm woodlots. These soils need artificial drainage if crops are to be grown in a rotation. The small acreage that has been drained is used for corn, oats, wheat, and hay.

MAPPING UNITS

McA0 McGregor sandy loam, 0 to 2 percent slopes. Soil management unit 3bA(IIW).
McB1 McGregor sandy loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 3bB(IIW).

Made Land

This miscellaneous land type consists of areas that have been covered by fill materials to such depths that the characteristics of the natural soil profile cannot be identified. Areas of this kind are found near the sugar beet factory in Croswell.

MAPPING UNIT

Md Made land. Soil management group S(VIIS).

Mancelona Series

Mancelona soils are well drained and moderately well drained and were developed on stratified calcareous sand and gravel. These soils occur on old deltas, the beach ridges of old glacial lakes, and other coarse-textured formations that were deposited by water. The native vegetation was mainly oak, sugar maple, beech, and basswood but included some white pine.

These soils are the well to moderately well drained member of the natural toposequence that includes the imperfectly drained Gladwin and the poorly drained Epoufette soils. The Mancelona soils are coarser textured than the Newaygo soils.

Profile description of a Mancelona loamy sand:

A_p 0 to 5 inches; loamy sand; dark gray, dark grayish brown, or very dark grayish brown (10YR 4/1, 4/2, or 3/2, moist); weak, fine, granular structure to single grain (structureless); very friable when moist and soft when dry; medium acid to neutral; 5 to 9 inches thick.

A_2 5 to 7 inches; sand to loamy sand; light gray to reddish gray (10YR 7/2 to 5YR 5/2, moist); single grain (structureless); loose; strongly to medium acid; 1 to 4 inches thick.

B_{2h} 7 to 14 inches; sand to loamy sand; yellowish brown, dark reddish brown, or brown (10YR 5/6, 5YR 3/3, or 7.5YR 5/4, moist); weak, fine, granular structure; very friable when moist and soft when dry; strongly to medium acid; 6 to 10 inches thick.

A_2 14 to 26 inches; sand; brown, dark brown, or dark yellowish brown (7.5YR 4/4 or 10YR 4/4, moist); very weak, fine, granular structure to single grain (structureless); very friable when moist; strongly to medium acid; 5 to 20 inches thick.

B_{2t} 26 to 29 inches; sandy loam to sandy clay loam; brown, dark brown, or yellowish brown (7.5YR 4/4, 10YR 4/3, or 5/4, moist); weak, medium, subangular blocky structure; slightly plastic when wet, firm when moist, and hard when dry; slightly acid to neutral; 2 to 10 inches thick.

C 29 inches+; sand and gravel; pale brown to yellow (10YR 6/3 to 7/6, moist); stratified; loose; calcareous.

The texture of the surface layer ranges from loamy sand to sandy loam. The calcareous, stratified sand and gravel generally occur at depths of less than 42 inches, but in places they are at depths of as much as 60 inches. On old beach ridges, the content of coarse sand and gravel is higher than it is in other formations. A high percentage of the gravelly material in the D horizon is limestone. The B_{2t} horizon ranges from a thin, slightly sticky layer of sandy loam to a sandy clay loam as much as 10 inches thick. In some areas the upper part of the A_2 horizon has been incorporated in the plow layer. Permeability is rapid. These soils are low in moisture-holding capacity and in natural fertility. They are susceptible to wind and water erosion.

Figure 10.—**Eskers, or old gravel ridges, are sources of road resurfacing materials. The soils are Mancelona and Newaygo.**

Most areas of Mancelona loamy sands with slopes of less than 8 percent have been cleared and are used for crops grown in rotation. Areas with slopes ranging from 8 to 15 percent are mostly in permanent pasture or woodlots. Very few areas with slopes of more than 15 percent have been cleared. The main crops are corn, oats, and hay. Yields of all crops are low. These soils generally do not produce good pasture, but some areas can be grazed in spring. The Mancelona soils are a potential source of gravel and sand (fig. 10).

MAPPING UNITS

MeA1 Mancelona loamy sand, 0 to 3 percent slopes, slightly eroded. Soil management unit 4aA(IIIS).
MeB1 Mancelona loamy sand, 3 to 8 percent slopes, slightly eroded. Soil management unit 4aB(IIIS).
MeB2 Mancelona loamy sand, 3 to 8 percent slopes, moderately eroded. Erosion has removed so much soil that the plow layer consists mostly of the former B_{2h} horizon. Soil management unit 4aB(IIIS).
MeC1 Mancelona loamy sand, 8 to 15 percent slopes, slightly eroded. Soil management unit 4aC(IIIS).
MeC2 Mancelona loamy sand, 8 to 15 percent slopes, moderately eroded. Erosion has removed so much of the soil that the plow layer consists mostly of the former B_{2h} horizon. A few severely eroded areas are included in this mapping unit. Soil management unit 4aC(IIIS).
MeD1 Mancelona loamy sand, 15+ percent slopes, slightly eroded. Soil management unit 4aE(VIIS).
MeD2 Mancelona loamy sand, 15+ percent slopes, moderately eroded. Soil management unit 4aE(VIIS).
MeD3 Mancelona loamy sand, 15+ percent slopes, severely eroded. Soil management unit 4aE(VIIS).

Marlette Series

Marlette soils were developed from calcareous loam to coarse clay loam glacial till. The native vegetation was mainly sugar maple and beech but included some oak, hickory, and basswood.

Marlette soils are the well-drained member of the natural toposequence that includes the imperfectly drained Capac and the poorly to very poorly drained Parkhill soils. Marlette soils have a lighter colored surface layer

than the Capac or Parkhill soils. They are more acid than the Guelph soils, and are deeper to calcareous materials. In Marlette soils, the calcareous substratum is at depths of 25 to 40 inches; but in the Guelph soils, the substratum is at depths of 15 to 25 inches. Marlette soils are finer textured than McBride soils, which were developed on sandy loam till.

Profile description of a Marlette loam:

A_1 0 to 3 inches; loam; dark grayish brown to very dark grayish brown (10YR 4/2 to 3/2, moist); moderate, fine, granular structure; slightly sticky when wet, friable when moist, and soft when dry; slightly acid to neutral; 2 to 4 inches thick.

A_2 3 to 6 inches; loam to fine sandy loam; light brownish gray, pale brown, or light yellowish brown (10YR 6/2, 6/3, or 2.5Y 6/4, moist); moderate, fine, granular structure to moderate, medium, platy structure; slightly sticky when wet, friable when moist, and soft when dry; strongly to slightly acid; 3 to 4 inches thick.

B_{2h} 6 to 11 inches; loam; brown to yellowish brown (10YR 5/3 to 5/6, moist); moderate, fine, granular structure to weak, medium, subangular blocky structure; slightly sticky when wet, friable when moist, and soft when dry; strongly to slightly acid; 4 to 7 inches thick.

A_2 11 to 15 inches; loam to fine sandy loam; pale brown to light yellowish brown (10YR 6/3 to 6/4, moist); weak, medium, subangular blocky structure; slightly hard when dry; strongly to slightly acid; 4 to 6 inches thick.

B_{2t} 15 to 30 inches; coarse clay loam to silty clay loam; dark yellowish brown, dark brown, brown, or yellowish brown (10YR 4/4, 4/3, or 5/6, moist); strong, medium to coarse, subangular blocky structure; plastic when wet, firm when moist, and very hard when dry; slightly acid to neutral; 10 to 20 inches thick.

C 30 inches+; loam; yellowish brown, pale brown, or light yellowish brown (10YR 5/4, 5/6, 6/3, or 6/4, moist); weak, medium to coarse, subangular blocky structure; plastic when wet, firm when moist, and hard when dry; calcareous.

The texture of the surface layer ranges from sandy loam to silt loam. The upper A_2 horizon and the B_{2h} horizon are distinct in wooded areas but are mixed into the surface layer when plowed. In areas that have the same kind of vegetation, runoff is medium on gently to moderately sloping areas and rapid on strongly sloping to steep areas.

More than 90 percent of the acreage of Marlette soils is used for crops grown in rotation, mainly corn, wheat, oats, barley, dry beans, sugar beets, and alfalfa. The main problems of management are control of water erosion and maintenance of fertility and organic matter.

MAPPING UNITS

MfA1 Marlette loam, 0 to 2 percent slopes, slightly eroded. Soil management unit 2aA(I).

MfB1 Marlette loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2aB(IIE).

MfB2 Marlette loam, 2 to 6 percent slopes, moderately eroded. Soil management unit 2aB(IIE).

MfB3 Marlette loam, 2 to 6 percent slopes, severely eroded. Water erosion has removed so much of the soil that the texture of the plow layer is loam to clay loam. Soil management unit 2aB(IIIE).

MfC1 Marlette loam, 6 to 12 percent slopes, slightly eroded. Soil management unit 2aC(IIIE).

MfC2 Marlette loam, 6 to 12 percent slopes, moderately eroded. Soil management unit 2aC(IIIE).

MfC3 Marlette loam, 6 to 12 percent slopes, severely eroded. The plow layer contains enough of the former B_{2t} horizon to have a loam to clay loam texture. Soil management unit 2aC(IVE).

MfD1 Marlette loam, 12 to 18 percent slopes, slightly eroded. Soil management unit 2aD(IVE).

MfD2 Marlette loam, 12 to 18 percent slopes, moderately eroded. Soil management unit 2aD(IVE).

MfD3 Marlette loam, 12 to 18 percent slopes, severely eroded. Erosion has removed so much of the upper horizons that the texture of the plow layer is loam to clay loam. Soil management unit 2aD(VIE).

MfE2 Marlette loam, 18 to 25 percent slopes, moderately eroded. Soil management unit 2aE(VIE).

MgA1 Marlette silt loam and loam, 0 to 2 percent slopes, slightly eroded. Soil management unit 2aA(I).

MgB1 Marlette silt loam and loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2aB(IIE).

MgB2 Marlette silt loam and loam, 2 to 6 percent slopes, moderately eroded. Soil management unit 2aB(IIE).

MgC1 Marlette silt loam and loam, 6 to 12 percent slopes, slightly eroded. Soil management unit 2aC(IIIE).

MgC2 Marlette silt loam and loam, 6 to 12 percent slopes, moderately eroded. Soil management unit 2aC(IIIE).

Melita and Arenac Series

Melita loamy sands and the Arenac loamy sands are mapped together as an undifferentiated unit. These soils were developed from sand to loamy sand that is 42 to 66 inches deep over loam to clay materials. The Melita soils are well to moderately well drained, and the Arenac soils are imperfectly drained. The native vegetation was mostly white pine but included some sugar maple, beech, and basswood.

These soils generally are associated with the moderately well drained Croswell soils, with the imperfectly drained Au Gres soils, and with other soils developed on deep sandy materials.

The Arenac soils are described under the heading, Eastport, Arenac, and Kalkaska Series.

Profile description of a Melita loamy sand:

A_1 0 to 2 inches; loamy sand; very dark grayish brown to dark grayish brown (10YR 3/2 to 4/2, moist); weak, fine, granular structure; very friable when moist and soft when dry; strongly to medium acid; 1 to 3 inches thick.

A_2 2 to 6 inches; sand; brown to pinkish gray (7.5YR 5/2 to 7/2, moist); weak, fine, granular structure to single grain (structureless); very friable to loose when moist and loose when dry; strongly to medium acid; 3 to 5 inches thick.

B_{21h} 6 to 10 inches; loamy sand to sand; dark reddish brown to dark reddish gray (5YR 3/4 to 4/2, moist); weak, fine, granular structure to single grain (structureless); very friable to loose when moist and loose when dry; strongly to medium acid; 3 to 5 inches thick.

B_{22h} 10 to 16 inches; sand; reddish brown to yellowish red (5YR 4/4 to 5/6, moist); weak, fine, granular structure to single grain (structureless); loose; in places weakly cemented; slightly acid; 4 to 12 inches thick.

C_1 16 to 30 inches; sand; pink to light yellowish brown (7.5YR 8/4 to 10YR 6/4, moist); single grain (structureless); loose; slightly acid to neutral; 10 to 20 inches thick.

C_2 30 to 45 inches; sand; pink to yellowish brown (7.5YR 8/4 to 10YR 5/4, moist); single grain (structureless); in many places appears to be compacted; neutral; 10 to 20 inches thick.

D 45 inches+; loam to clay; reddish brown (2.5YR 4/4 to 5YR 5/4, moist); massive (structureless); plastic when wet, very firm when moist, and hard to very hard when dry; calcareous.

The texture of the surface layer ranges from loamy sand to coarse sandy loam. The D horizon ranges from loam to clay in texture and occurs at depths of 42 to 66 inches.

Most of the acreage of these soils is in permanent pasture and woodlots. Some areas are in crops, but yields

are fair to poor because these soils have low natural fertility and low moisture-holding capacity. Late summer crops often fail because moisture is scarce. If these soils are cultivated, wind erosion is a serious problem.

MAPPING UNITS

MhA1 Melita and Arenac loamy sands, 0 to 2 percent slopes, slightly eroded. Soil management unit 5aA(IVS).

MhB1 Melita and Arenac loamy sands, 2 to 7 percent slopes, slightly eroded. A few moderately eroded areas are included in this mapping unit. Soil management unit 5aB(IVS).

Melita Series

This series consists of well to moderately well drained soils that occur on old lake plains and old, narrow, steep-sided beach ridges. They were developed from sand to loamy sand that is 42 to 66 inches deep over loam to clay. The native vegetation was mainly white pine but included some sugar maple, beech, and basswood.

These soils are in the natural toposequence that includes the imperfectly drained Arenac and the poorly drained Roscommon soils.

Most areas of Melita soils are in pasture or second-growth forest. Most of the cleared acreage is idle or is used for limited grazing.

A profile of a Melita loamy sand is described under the heading, Melita and Arenac Series.

MAPPING UNITS

MkC1 Melita loamy sand, 7 to 14 percent slopes, slightly eroded. Small, moderately eroded areas are included in this mapping unit. Soil management unit 5aC(IVS).

MkD2 Melita loamy sand, 14+ percent slopes, slightly to severely eroded. Soil management unit 5aD(VIIS).

Menominee Series

Menominee soils are well to moderately well drained loamy sands that are 18 to 42 inches deep over calcareous loam to silty clay loam. The native vegetation on these soils consisted of dense stands of mixed hardwoods and conifers.

These soils are in the natural toposequence that includes the imperfectly drained Iosco soils. The fine-textured D horizon in the Menominee soils is nearer the surface than in the Melita soils.

Profile description of a Menominee loamy sand:

A_p 0 to 6 inches; loamy sand; very dark grayish brown (10YR 3/2, moist); weak, fine, granular structure; very friable when moist and soft when dry; medium acid to neutral; 6 to 10 inches thick.

A_2 6 to 7 inches; sand to loamy sand; light gray (10YR 7/2, moist); weak, thin, platy structure; loose; strongly to slightly acid; 1 to 5 inches thick.

B_{21h} 7 to 13 inches; sand to loamy sand; dark yellowish brown (10YR 4/4, moist); weak, fine, granular structure; very friable when moist and slightly hard when dry; medium to slightly acid; 4 to 8 inches thick.

B_{22h} 13 to 24 inches; sand to loamy sand; yellowish brown 10YR 5/4, moist); weak, fine, granular structure; very friable when moist and slightly hard when dry; slightly acid; 8 to 15 inches thick.

C_1 24 to 27 inches; sand; pale brown to light yellowish brown (10YR 6/3 to 6/4, moist); loose; slightly acid to neutral; 3 to 15 inches thick.

D 27 inches+; loam to silty clay loam; dark grayish brown to pale brown (10YR 4/2 to 6/3, moist); moderate, medium, angular blocky structure; sticky to plastic when wet, firm when moist, and hard when dry; calcareous.

In some places the B_{22h} and C_1 horizons have lenses of material finer textured than loamy sand. The depth to the D horizon varies from 18 to 42 inches, and the thickness of the layers above varies accordingly. Permeability is rapid.

These moderately sloping Menominee soils are used mostly for pasture.

MAPPING UNITS

MmC1 Menominee loamy sand, 6 to 12 percent slopes, slightly eroded. Soil management unit 4aC(IIIS).

MmC2 Menominee loamy sand, 6 to 12 percent slopes, moderately eroded. Soil management unit 4aC(IIIS).

Montcalm Series

Montcalm soils are well drained. They were developed from sand to loamy sand materials. The native vegetation on these soils was mainly white pine, sugar maple, beech, and basswood.

These soils are in the same natural toposequence as the imperfectly drained Otisco soils and the poorly and very poorly drained Edmore soils. The Montcalm soils are not so fine textured as the McBride soils, which were developed from sandy loam parent material. They are finer textured than the Kalkaska soils, which were developed from sandy material.

Profile description of a Montcalm loamy sand:

A_1 0 to 2 inches; loamy sand; very dark grayish brown (10 YR 3/2, moist); weak, medium, granular structure; friable when moist and soft when dry; slightly to strongly acid; 1 to 3 inches thick.

A_2 2 to 5 inches; fine loamy sand; pale brown to light gray (10YR 6/3 to 7/2, moist); single grain (structureless); strongly acid; 1 to 5 inches thick.

B_{2h} 5 to 9 inches; loamy sand to coarse sandy loam; yellowish red to brown (5YR 4/8 to 7.5YR 5/4, moist); weak, medium, granular structure that shows some cementation in places; friable when moist and soft when dry; slightly acid; 3 to 8 inches thick.

A_2 9 to 27 inches; fine sand to coarse sandy loam; yellowish brown to brownish yellow (10YR 5/4 to 6/6, moist); single grain (structureless) to weak, fine, granular structure; nonsticky when wet, very friable when moist, and loose when dry; slightly acid; 15 to 20 inches thick.

B_{2t} 27 to 37 inches; sandy loam to sandy clay loam; light yellowish brown to reddish brown (10YR 6/4 to 5YR 4/4, moist); weak, medium, subangular blocky structure; sticky when wet, friable when moist, and hard when dry; medium to strongly acid; 2 to 10 inches thick.

A_2 and B_2 sequence 37 to 68 inches; sand to loamy sand with dark-brown to brown (7.5YR 4/4, moist) lenses of loamy sand to sandy loam; slightly to medium acid.

C 68 inches+; sand to loamy sand; light yellowish brown to yellowish brown (10YR 6/4 to 5/6, moist); loose; calcareous.

The initial plowing mixed the A_1, A_2, and most of the B_{2h} horizon. The upper horizons described occur only in wooded areas. Runoff is medium on the more nearly level slopes and rapid on the strongly sloping areas. Internal drainage is rapid.

These soils are generally low in moisture-holding capacity and contain little organic matter. They are easily tilled, however, and warm early in spring. They respond well to fertilizer and manure.

Montcalm soils that have slopes less than 12 percent are used mainly for crops grown in rotation. Areas having slopes of more than 12 percent are largely in pasture or second-growth forest. Productivity is low to

medium. Water and wind erosion need to be controlled in cleared areas.

MAPPING UNITS

MnA1 Montcalm loamy sand, 0 to 2 percent slopes, slightly eroded. Soil management unit 4aA(IIIS).

MnB1 Montcalm loamy sand, 2 to 6 percent slopes, slightly eroded. Soil management unit 4aB(IIIS).

MnB2 Montcalm loamy sand, 2 to 6 percent slopes, moderately eroded. Erosion has removed so much material that the plow layer consists mostly of soil material from the lighter colored lower A_2 horizon. This soil has lower yields than the Montcalm loamy sands that are not eroded. Soil management unit 4aB(IIIS).

MnC1 Montcalm loamy sand, 6 to 12 percent slopes, slightly eroded. Soil management unit 4aC(IIIS).

MnC2 Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded. Erosion has removed so much material that the plow layer consists mostly of soil material from the lower A_2 horizon. Soil management unit 4aC(IIIS).

MnD1 Montcalm loamy sand, 12 to 18 percent slopes, slightly eroded. Soil management unit 4aD(IVS).

MnD2 Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded. About 20 percent of this mapping unit is severely eroded. Soil management unit 4aD(IVS).

Newaygo Series

In the Newaygo series are well-drained soils that were developed on stratified limy sand and gravel. They occupy nearly level to sloping areas on outwash plains and old beach ridges. The native vegetation on these soils was mostly hardwoods but included some white pine. The hardwoods are mainly sugar maple, beech, and yellow birch.

These soils are in the natural toposequence that includes the imperfectly drained Palo and the poorly to very poorly drained Ronald soils. The subsoil in the Newaygo soils is thicker and finer textured than that in the Mancelona soils and is at a shallower depth.

Profile description of a Newaygo sandy loam:

A_p 0 to 7 inches; sandy loam; very dark grayish brown to dark grayish brown (10YR 3/2 to 4/2, moist); weak, fine, granular structure; friable when moist and soft to slightly hard when dry; moderate amount of organic matter; slightly acid to neutral; 5 to 8 inches thick.

B_{2h} 7 to 9 inches; sandy loam to loamy fine sand; brown, dark brown, or light brownish gray (10YR 4/3 or 6/2, moist); moderate, medium, granular structure; friable when moist and slightly hard when dry; slightly acid to neutral; 1 to 4 inches thick.

B_{1t} 9 to 14 inches; sandy loam; dark yellowish brown, yellowish brown, or dark brown to brown (10YR 4/4, 5/4, or 7.5YR 4/4, moist); weak, fine to medium, granular structure; friable when moist and slightly hard when dry; slightly acid to neutral; 3 to 6 inches thick.

B_{2t} 14 to 24 inches; sandy loam to sandy clay loam; brown to dark brown (7.5YR 5/4 to 4/4, moist); weak, medium, subangular blocky structure; sticky when wet, firm when moist, and hard when dry; slightly acid to neutral; 5 to 10 inches thick.

D 24 inches+; gravel and sand; brown, yellowish brown, or light yellowish brown (10YR 5/3, 5/4, or 6/4, moist); stratified; loose; calcareous.

The texture of the surface layer ranges from loamy sand to fine sandy loam. The depth to the D horizon ranges from 24 to 42 inches. Areas that are deeper to the D horizon have thicker upper horizons in the profile. West of the Black River, calcareous sands and gravel occur at greater depths than in other parts of the county.

Newaygo soils are not excessively droughty, but their low to moderate water-holding capacity is a limiting factor. They are easily tilled, however, and respond to fertilizer, lime, and manure.

Newaygo soils that have slopes of less than 6 percent are used mostly for crops grown in rotation; those having slopes of more than 6 percent are used for permanent pasture or farm woodlots. The main crops are corn, oats, dry beans, and alfalfa. If the strongly sloping areas are cultivated, water-erosion practices are needed.

MAPPING UNITS

NaA1 Newaygo sandy loam, 0 to 2 percent slopes, slightly eroded. Soil management unit 3aA(IIS).

NaB1 Newaygo sandy loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 3aB(IIS).

NaC1 Newaygo sandy loam, 6 to 12 percent slopes, slightly eroded. This mapping unit occurs in long narrow bands that form the breaks between higher land and natural drainageways. Soil management unit 3aC(IIIS).

NaC2 Newaygo sandy loam, 6 to 12 percent slopes, moderately eroded. This soil is generally less productive than the slightly eroded Newaygo sandy loams. Some steeper slopes and severely eroded areas are included in this mapping unit. Soil management unit 3aC(IIIS).

Otisco Series

Otisco soils are imperfectly drained and were developed in calcareous or neutral loamy sand materials. The native vegetation was mixed hardwoods and some white pine. The hardwoods are mainly elm, swamp white oak, sugar maple, and beech.

These soils are in the natural toposequence that includes the lighter colored, well-drained Montcalm soils and the dark-colored, poorly to very poorly drained Edmore soils. The Otisco soils are coarser textured than the Coral soils, which were developed from sandy loam parent materials. They are finer textured than Au Gres soils, which were developed from sandy parent material.

Profile description of an Otisco loamy sand:

A_p 0 to 8 inches; loamy sand; dark brown, brown to very dark grayish brown (10YR 4/3 to 3/2, moist); weak, fine, granular structure; very friable when moist and soft when dry; moderate to high in organic matter; medium acid; 6 to 9 inches thick.

A_2 8 to 11 inches; loamy sand; brown to yellowish brown (10YR 5/3 to 5/4, moist); weak, fine, granular structure to weak, thin, platy structure; very friable when moist and soft when dry; strongly to medium acid; 3 to 5 inches thick.

B_{2hg} 11 to 18 inches; loamy sand; yellowish brown to dark yellowish brown (10YR 5/6 to 4/4, moist), mottled with yellow (10YR 7/8, moist); weak, medium, granular structure; very friable when moist and soft when dry; medium to slightly acid; 5 to 8 inches thick.

A_{2g} 18 to 24 inches; loamy sand; brown to pale brown (10YR 5/3 to 6/3, moist), mottled with brownish yellow (10YR 6/6, moist); weak, medium, granular structure to weak, thin, platy structure; very friable when moist and soft when dry; medium to slightly acid; 5 to 8 inches thick.

B_{21t} 24 to 32 inches; loamy sand to sandy loam; yellowish brown to dark yellowish brown (10YR 5/6 to 4/4, moist); weak, medium, subangular blocky structure; friable to very friable when moist and soft when dry; slightly acid; 7 to 12 inches thick.

B_{22t} 32 to 44 inches; coarse sandy clay loam; strong brown, dark brown, or brown (7.5YR 5/6, or 4/4, moist); weak to moderate, coarse, subangular blocky structure; slightly plastic when wet, firm when moist and hard when dry; slightly acid to neutral; 6 to 16 inches thick.

C 44 inches+; loamy sand to sand; very pale brown to brownish yellow (10YR 7/4 to 6/6, moist); single grain (structureless); very friable when moist and soft when dry; neutral to calcareous.

The texture of the surface layer varies from loamy sand to sandy loam. The B_{2hg} horizon may be barely discernible or strongly developed. In places a series of thin B horizons of loamy sand to sandy loam texture have developed below the second A_2 horizon.

More than half of the acreage in Otisco soils is in permanent pasture or woodlots. The rest is used mainly for crops grown in rotation. Adequate drainage is a problem in most areas.

MAPPING UNITS

OaA0 Otisco loamy sand, 0 to 2 percent slopes. Soil management unit 4bA(IIIW).

OaB1 Otisco loamy sand, 2 to 6 percent slopes, slightly eroded. Soil management unit 4bB(IIIW).

Palms Series

Palms muck was developed from fibrous plant materials that are 12 to 42 inches deep over fine sandy loam to silty clay loam mineral materials. The natural drainage is very poor, and the water table is at or near the surface in wet periods. Sedges and grasses made up most of the native vegetation, but some shrubs and scattered trees were included.

The Palms muck is generally associated with poorly to very poorly drained mineral soils. It has organic materials that are similar to those in the Houghton muck, but the organic materials in the Houghton muck extend deeper than 42 inches. In some areas where they occur close together, Palms muck and Houghton muck are mapped together as an undifferentiated unit. Palms muck was developed from fibrous parent material; the Linwood, from mixed woody and fibrous organic materials.

Profile description of a Palms muck:

01 0 to 10 inches; muck; very dark brown to black (10YR 2/2 to 2/1, moist); well decomposed; moderate, medium, granular structure; friable when moist and hard when dry; slightly acid to neutral; 8 to 10 inches thick.

02 10 to 22 inches; fibrous peat; very dark brown to dark yellowish brown (10YR 2/2 to 4/4, moist); slightly acid to neutral; 5 to 30 inches thick.

03 22 to 24 inches; pasty sedimentary organic material; light gray, gray, or light yellowish brown (10YR 6/1 to 6/4, moist); slightly acid to neutral; 1 to 4 inches thick.

D 24 inches+; sandy loam to coarse clay loam; gray, light gray, or light yellowish brown (10YR 6/1 or 6/4, moist); massive (structureless); in many places appears to be stratified; slightly sticky when wet, firm when moist, and hard when dry; calcareous.

The decomposition of the organic layers varies considerably. The depth to underlying mineral materials ranges from 12 to 42 inches.

Cleared and drained areas of the Palms muck are used for special crops and field crops. A considerable acreage is in permanent pasture.

MAPPING UNIT

PaA0 Palms muck, 0 to 2 percent slopes. Soil management unit M/3c(IIW).

Palms and Adrian Series

Where the Palms muck and the Adrian muck occur closely together in Sanilac County, they are mapped as an undifferentiated unit. These soils have poor to very poor natural drainage. They were developed in depressions and along larger natural drainageways. The native vegetation was mainly sedges and grasses but included some scattered shrubs and small trees.

***Figure 11.*—Mint on Palms and Adrian mucks in the foreground. Capac loam in the background. Dwellings of itinerant farm workers at foot of slopes.**

These soils were developed from fibrous, reedy, and sedgy materials that vary in degree of decomposition. In places some woody material is visible in the upper horizons. The depth to the underlying material ranges from 12 to 42 inches. The organic material in the Palms muck is underlain by sandy loam to silty clay loam, and that in the Adrian muck is underlain by sand to loamy sand.

Profiles of the Palms muck and the Adrian muck are described under their respective series headings.

Cleared and drained areas of Palms and Adrian mucks are used for special and field crops (fig. 11). The rest is mainly in permanent pasture. In wet seasons, the water table is at or near the surface.

MAPPING UNIT

PbA0 Palms and Adrian mucks, 0 to 2 percent slopes. Soil management unit M/3c(IIW).

Parkhill Series

Parkhill soils were developed from calcareous loamy materials. They generally occur in poorly to very poorly drained areas on slightly undulating plains or in depressional areas. The native vegetation on these soils was mainly elm, ash, swamp white oak, basswood, and red maple.

West of the Black River, the Parkhill soils are associated with the well-drained Marlette soils and the imperfectly drained Capac soils. East of the Black River, they are associated with the well-drained Guelph soils and the imperfectly drained London soils. The Parkhill soils have a darker colored surface layer than the Marlette, Capac, Guelph, and London soils. They are lighter colored than the organic soils in the county.

Profile description of a Parkhill loam:

A_p 0 to 7 inches; loam; very dark gray to very dark brown (10YR 3/1 to 2/2, moist); weak, fine, granular structure; slightly sticky when wet, friable when moist, and slightly

Figure 12.—**Alfalfa on a Parkhill loam.**

Figure 13.—**Tile laid out on a Parkhill loam before installation. Elm and ash in background.**

hard when dry; high content of organic matter; slightly acid to mildly alkaline; 5 to 8 inches thick.

GA 7 to 12 inches; loam; grayish brown to dark grayish brown (10YR 5/2 to 2.5Y 4/2, moist), mottled with yellowish brown (10YR 5/4, moist); weak, medium, granular structure; slightly sticky when wet, friable when moist, and hard when dry; medium acid to mildly alkaline; 4 to 6 inches thick.

GB$_1$ 12 to 16 inches; loam to silt loam; gray to light gray (10YR 5/1 to 5Y 6/1, moist), mottled with yellowish brown (10YR 5/6, moist); moderate, medium, blocky structure; plastic when wet, firm when moist, and very hard when dry; medium acid to mildly alkaline; 4 to 6 inches thick.

GB$_2$ 16 to 30 inches; loam to clay loam; light brownish gray to grayish brown (2.5Y 6/2 to 2.5Y 5/2, moist), mottled with yellowish brown (10YR 5/4, moist); strong, coarse, angular blocky structure; plastic when wet, firm when moist, and very hard when dry; medium acid to mildly alkaline; 10 to 22 inches thick.

GB$_3$ 30 to 36 inches; loam to silty clay loam; gray to light gray (5Y 6/1, moist), mottled with yellowish brown (10YR 5/4, moist); plastic when wet, firm when moist, and very hard when dry; slightly acid to mildly alkaline; 5 to 8 inches thick.

C 36 inches+; loam; olive gray to dark gray (5Y 5/2 to 4/1, moist), mottled with yellowish brown (10YR 5/4, moist); moderate, coarse, angular blocky structure; sticky when wet, firm when moist, and very hard when dry; calcareous.

The texture of the surface layer is loam, clay loam, or mucky loam. Lime occurs at depths of 20 to 60 inches. East of the Black River, the depth to lime is generally less than it is in the rest of the county and the soils are neutral to mildly alkaline. The lower horizons are stratified in many areas.

Parkhill soils are mainly in corn, oats, hay, and other crops used in dairy farming (fig. 12). Wheat, dry beans, and sugar beets are grown as cash crops. These soils have a high available water-holding capacity, but they need tile and surface drains to remove excess water (fig. 13). Where drainage is adequate, these soils are highly productive. They need to be carefully managed to maintain tilth and to prevent the plow layer from puddling and packing.

MAPPING UNITS

PcA0 Parkhill loam, 0 to 2 percent slopes. Soil management unit 2cA(I).

PcB1 Parkhill loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 2cA(I).

PdA0 Parkhill loam and clay loam, 0 to 2 percent slopes. This is the most extensive mapping unit in the county. Soil management unit 2cA(I).

PeA0 Parkhill loam and mucky loam, 0 to 2 percent slopes. The surface layer ranges from muck, less than 12 inches deep, to a dark-colored mineral soil that is moderately high in organic matter. Soil management unit 2cA(I).

Perth Series

Perth soils are imperfectly drained and were developed from calcareous clay loam to silty clay loam glacial till. The native vegetation was mainly elm, ash, sugar maple, beech, and basswood.

These soils are in the natural toposequence that includes the well and moderately well drained Huron soils. They are finer textured than the Capac and London soils, which were developed from loam till.

Profile description of Perth silt loam:

A_p 0 to 6 inches; silt loam; dark gray (10YR 4/1, moist); strong, medium to fine, granular structure; friable when moist and slightly hard when dry; slightly acid; 6 to 8 inches thick.

A_{2g} 6 to 8 inches; silt loam to silty clay loam; light brownish gray (10YR 6/2, moist), mottled with dark grayish brown (2.5Y 4/2, moist); strong, medium, granular structure; slightly plastic when wet, friable when moist, and hard when dry; neutral; 2 to 4 inches thick.

B_{21g} 8 to 14 inches; silty clay loam; dark grayish brown (10YR 4/2, moist), mottled with grayish brown (2.5Y 5/2, moist); strong, fine to medium, angular blocky structure; plastic when wet, firm when moist, and hard when dry; neutral to mildly alkaline; 6 to 8 inches thick.

C_g 14 inches+; silty clay loam; light olive brown (2.5Y 5/4, moist), mottled with grayish brown (2.5Y 5/2, moist); strong, medium, angular blocky structure; very plastic when wet, firm when moist, and very hard when dry; calcareous.

The texture of the surface layer ranges from a silt loam to a silty clay loam. Runoff is slow, and permeability is moderately slow to slow. The depth to calcareous parent material ranges from 12 to 30 inches. This soil is used largely for field crops.

MAPPING UNIT

PfA0 Perth silt loam, 0 to 2 percent slopes. Soil management unit 2bA(I).

Figure 14.—**Unimproved pasture on Richter and Tonkey soils in old glacial drainageway in Greenleaf Township.**

Richter and Tonkey Series

Where they occur close together in Sanilac County, Richter soils and Tonkey soils were mapped together as an undifferentiated unit. The Richter soils are imperfectly drained, and the Tonkey soils are poorly drained. These soils were developed on stratified sands, gravel, and sandy loams. They are in old glacial drainageways and on outwash plains (fig. 14). In glacial periods, immense quantities of water flowed through these drainageways and on these plains. Undisturbed areas have a thin accumulation of organic material that disappears when the soils are cultivated. The native vegetation was mixed hardwoods and conifers. The hardwoods were mainly elm, ash, red maple, beech, and basswood.

The Richter soils are coarser textured than the Capac or London soils. They are more stratified than Coral soils and are not so coarse textured as Otisco soils. A profile of a Tonkey soil is described under the heading, Tonkey Series.

Profile description of a Richter sandy loam:

A_p 0 to 7 inches; sandy loam; very dark grayish brown (10YR 3/2, moist); weak, fine, granular structure; friable when moist and soft when dry; slightly acid to mildly alkaline; 6 to 10 inches thick.

B_{2hg} 7 to 12 inches; loamy sand; pale brown to yellowish brown (10YR 6/3 to 5/4, moist), mottled with strong brown (7.5YR 5/6, moist); weak, fine, granular structure to single grain (structureless); friable when moist and soft when dry; slightly to medium acid; 3 to 8 inches thick.

B_{2tg} 12 to 24 inches; loam to sandy clay loam; yellowish brown (10YR 5/4 to 5/8, moist), mottled with strong brown (7.5YR 5/6, moist); weak to moderate, medium, subangular blocky structure; sticky when wet, firm when moist, and hard when dry; slightly acid to mildly alkaline; 8 to 20 inches thick.

C_g 24 inches+; sand, gravel, sandy loam, and loam; light yellowish brown (2.5Y 6/4, moist), mottled with strong brown (7.5YR 5/6, moist); stratified; contains some very fine sand and silt; structure and consistence vary with texture; calcareous.

Many areas have enough stones and boulders on the surface to interfere with cultivation. The texture of the plow layer ranges from sandy loam to loam. The mottling in the subsoil horizons and the substratum ranges from faint to prominent.

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The stony and bouldery areas are in permanent pasture or forest. The rest of the acreage is used mainly for corn, wheat, oats, sugar beets, field beans, and hay.

MAPPING UNITS

RaA0 Richter and Tonkey bouldery sandy loam and loam, 0 to 2 percent slopes. Soil management unit 3bA(IIW).

RaB1 Richter and Tonkey bouldery sandy loam and loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 3bB(IIW).

Rifle Series

Rifle soils were developed, under very poor drainage, from woody and fibrous plant materials more than 42 inches deep. The native vegetation consisted mainly of mixed swamp hardwoods and conifers, and the second growth is mostly aspen, red maple, and tamarack.

These soils differ from Houghton soils, which developed mostly from fibrous organic materials. Rifle soils developed from parent material similar to that of the Tawas soils, but the Tawas soils are underlain by coarse-textured materials at depths of 12 to 42 inches. The organic materials in Rifle soils are less decomposed than those in the Carlisle soils and are decomposed to a shallower depth.

Profile description of a Rifle peat:

01 0 to 14 inches; coarse peat; black to dark brown or brown (10 YR 2/1 to 4/3, moist); contains woody fragments or roots; strongly to slightly acid; 6 to 24 inches thick.

02 14 inches+; coarse fibrous peat; brown to yellowish brown (10YR 5/3 to 5/4, moist); with increasing depth the peat is more fibrous, lighter brown in color, and more acid in reaction.

In wet periods the water table is at or near the surface. In places the sandy overwash from adjacent eroded slopes partly covers small areas.

Most of this soil is in the game area southwest of Minden City and is used for forestry or as a wildlife habitat.

MAPPING UNIT

RbA0 Rifle peat, 0 to 2 percent slopes. Soil management unit Mc(IIIW).

Roscommon Series

Roscommon soils were developed from deep, slightly acid to neutral sands under poor to very poor drainage. Much of the time, the water table is at or near the surface. The native vegetation was mostly swamp hardwoods and conifers. The second growth is mainly willow, alder, aspen, and red maple.

The Roscommon soils are generally associated with the imperfectly drained Au Gres sands and with shallow organic soils over sands or loamy sands (fig. 15).

Soil profile description of Roscommon loamy sand:

A_1 0 to 4 inches; loamy sand; black (10YR 2/1, moist); very weak, fine, granular structure; very friable when moist and soft when dry; high in organic matter; neutral to slightly acid; 2 to 12 inches thick.

GA 4 to 25 inches; sand; dark grayish brown, dark gray, light brownish gray, or light gray (10YR 4/2, 4/1, 6/2, or 7/1, moist); single grain (structureless); loose; slightly acid to neutral; 10 to 25 inches thick.

GB 25 to 45 inches; sand; pale brown, dark grayish brown, dark brown, or brown (10YR 6/3, 4/2, or 4/3, moist); single grain (structureless); loose; neutral to mildly alkaline; 14 to 25 inches thick.

***Figure 15.*—In foreground, Roscommon mucky loamy sand, 0 to 2 percent slopes, and Palms muck, 0 to 2 percent slopes; in background, McBride and Montcalm soils.**

C 45 inches+; sand to gravelly sand; gray, brown, or very pale brown (10YR 5/1, 5/3, or 7/4, moist); single grain (structureless); loose; neutral to calcareous.

Undisturbed areas of Roscommon soils generally have a mucky surface layer 2 to 12 inches thick.

Roscommon soils are mostly in pasture and second-growth forest, but some hay is also grown. These soils are too wet and sandy to be used for most field crops.

MAPPING UNITS

RcA0 Roscommon loamy sand, 0 to 2 percent slopes. Soil management unit 5cA(IVW).

RdA0 Roscommon mucky loamy sand, 0 to 2 percent slopes. Undisturbed areas have a surface layer of organic materials 2 to 12 inches thick. Where plowed, the surface layer is mucky loamy sand. Soil management unit 5cA(IVW).

Rubicon Series

Rubicon soils were developed from deep, well-drained sands that contained little lime. The native vegetation was mainly mixed hardwoods and red and white pines but included some jack pine.

These well drained soils are generally associated with the moderately well drained Croswell, the imperfectly drained Au Gres, and the poorly drained Roscommon soils. They do not have the finer textured B_2 horizons that characterize the soils that developed from fine-textured materials.

Profile description of a Rubicon sand:

A_1 0 to 2 inches; sand; grayish brown to dark grayish brown (10YR 5/2 to 4/2, moist); weak, fine, granular structure to single grain (structureless); very friable when moist and soft when dry; medium to slightly acid; ½ to 3 inches thick.

A_2 2 to 8 inches; sand; light gray, light yellowish brown, or yellow (10YR 7/1, 6/4, or 7/6, moist); single grain (structureless); loose; medium to strongly acid; 1 to 12 inches thick.

B_{2h} 8 to 24 inches; sand; strong brown, yellowish brown, or yellow (7.5YR 5/6, 10YR 5/4, or 7/8, moist); single grain (structureless); loose; medium to strongly acid; 6 to 16 inches thick.

C_1 24 inches+; sand; very pale brown, yellow, or light brownish gray (10YR 7/3, 7/6, or 6/2, moist); single grain (structureless); loose; slightly to medium acid.

The texture of the surface layer ranges from sand to loamy sand. Calcareous material generally occurs below a depth of 66 inches.

These soils have very rapid internal drainage and low available moisture-holding capacity. They contain a small amount of plant nutrients. Cleared areas are susceptible to wind erosion.

Rubicon soils are mostly in pasture and second-growth forest. Areas that have been cleared and farmed are now idle or are used for limited grazing.

MAPPING UNITS

ReA1 Rubicon sand, 0 to 2 percent slopes, slightly eroded. Soil management unit 5.3aA(VIIS).

ReB1 Rubicon sand, 2 to 7 percent slopes, slightly eroded. Soil management unit 5.3aA(VIIS)

ReB3 Rubicon sand, 2 to 7 percent slopes, moderately or severely eroded. Erosion has removed so much material that the surface layer consists mostly of the former, dark-colored B_{2h} horizon. Soil management unit 5.3aC(VIIS.)

ReC1 Rubicon sand, 7 to 14 percent slopes, slightly eroded. Soil management unit 5.3aC(VIIS).

ReC2 Rubicon sand, 7 to 14 percent slopes, moderately or severely eroded. Erosion has removed so much material that the plow layer consists mostly of the former, dark-colored B_{2h} horizon. Soil management unit 5.3aC(VIIS).

ReD1 Rubicon sand, 14+ percent slopes, slightly eroded. Soil management unit 5.3aC(VIIS).

ReD3 Rubicon sand, 14+ percent slopes, moderately or severely eroded. Erosion has removed so much material that the plow layer consists mostly of the former, dark-colored B_{2h} horizon. Soil management unit 5.3aC(VIIS).

Sanilac Series

Sanilac soils are imperfectly drained and were developed from stratified, calcareous silt and very fine sand that have some clay lenses. These soils occur mainly on nearly level old lake plains. Only a shallow profile has developed, and calcareous materials are at or within 10 inches of the surface. The native vegetation was mainly hardwoods but included some white pine.

These soils are in the natural toposequence that includes the moderately well drained Gagetown soils and the poorly drained to very poorly drained, dark-colored Bach soils.

Profile description of a Sanilac silt loam:

A_p 0 to 8 inches; silt loam; dark gray, very dark gray, or grayish brown (10YR 4/1, 3/1, or 5/2, moist); moderate, medium to coarse, granular structure; friable when moist and slightly hard when dry; mildly alkaline or calcareous; 6 to 8 inches thick.

B_{2h} 8 to 12 inches; silt loam; dark grayish brown to pale brown (10YR 4/2 to 6/3, moist); moderate, medium, granular structure; friable when moist and slightly hard when dry; mildly alkaline to calcareous; 3 to 5 inches thick.

B_{3tg} 12 to 15 inches; loam to silt loam; dark grayish brown to grayish brown (10YR 4/2 to 5/2, moist), mottled with dark yellowish brown (10YR 4/4, moist); moderate, medium, subangular blocky structure; slightly sticky when wet, friable when moist, and slightly hard when dry; calcareous; 3 to 8 inches thick.

C 15 inches+; very fine sand and silt with lenses of clay; pale brown to light yellowish brown (10YR 6/3 to 6/4, moist); stratified; calcareous.

The texture of the stratified, calcareous material ranges from fine sand to clay. Runoff and internal drainage are slow.

Sanilac soils are used mainly for crops grown in rotation and for permanent pasture.

MAPPING UNITS

SaA0 Sanilac silt loam, 0 to 2 percent slopes. Soil management unit 3bA(IIW).

SaB1 Sanilac silt loam, 2 to 6 percent slopes, slightly eroded. Small areas of moderately well drained soils are included with this soil. Soil management unit 3bB(IIW).

Saverine and Iosco Series

Where they occur together in Sanilac County, the imperfectly drained Saverine and Iosco soils are mapped as an undifferentiated unit.

The Saverine soils formed from fine sand, very fine sand, and silt, 18 to 42 inches deep over loam to silty clay loam. The Iosco soils, in contrast, formed from sand or loamy sand, 18 to 42 inches deep over loam to silty clay loam. The native vegetation on Savarine and Iosco soils was mainly hardwoods but included some conifers.

A profile of an Iosco soil is described under the heading, Iosco and Croswell Series.

Profile description of a Saverine fine sandy loam:

A_p 0 to 7 inches; fine sandy loam; very dark grayish brown to very dark gray (10YR 3/2 to 3/1, moist); weak, fine, granular structure; friable when moist and soft when dry; medium in organic-matter content; slightly acid to neutral; 6 to 9 inches thick.

A_2 7 to 9 inches; fine to very fine sandy loam; pale brown to very pale brown (10YR 6/3 to 7/3, moist); weak, thin, platy structure; very friable when moist and soft when dry; slightly acid to neutral; 1 to 6 inches thick.

B_{2hg} 9 to 12 inches; fine sandy loam; brown to dark brown (10YR 4/3, moist), mottled with pale brown (10YR 6/3, moist); weak, fine, granular structure to weak, medium, platy structure; slightly cemented; friable when moist and slightly hard when dry; slightly acid to neutral; 2 to 5 inches thick.

B_{2tg} 12 to 19 inches; fine to very fine sandy loam; light yellowish brown to pale brown (10YR 6/4 to 6/3, moist), mottled with yellowish brown (10YR 5/4, moist); weak, medium, subangular blocky structure; friable when moist and slightly hard when dry; slightly acid to neutral; 5 to 8 inches thick.

C_g 19 to 30 inches; fine sand, very fine sand, and silt; yellowish brown to brown (10YR 5/4 to 7.5YR 5/4, moist), mottled with brownish yellow (10YR 6/6, moist); stratified; loose; friable when moist and soft when dry; slightly acid to neutral; 5 to 30 inches thick.

D 30 inches+; loam to silty clay loam; light brownish gray, brown, or light olive brown (10YR 6/2, 5/3, or 2.5Y 5/4, moist); massive (structureless); plastic when wet and firm when moist; calcareous.

The fine sandy loam and silty upper horizons range from 18 to 42 inches in depth. The mottles range from prominent in the more poorly drained areas to faint in the imperfectly drained areas.

These soils are in field crops, permanent pasture, or woodlots. Adequate drainage is needed if field crops are grown. Tile is difficult to install, however, because of the variable thickness of the fine sandy loam and silty upper layers. The suitability of these soils for field crops increases as the thickness of the upper layers decreases.

MAPPING UNITS

SbA0 Saverine and Iosco fine sandy loams, 0 to 2 percent slopes. Soil management unit 3bA(IIW).

SbB1 Saverine and Iosco fine sandy loams, 2 to 7 percent slopes, slightly eroded. Mottles are faint. Soil management unit 3bB(IIW).

Figure 16.—**Spalding peat, 0 to 2 percent slopes, that has been cleared so that commercial peat can be removed.**

SbB2 Saverine and Iosco fine sandy loams, 2 to 7 percent slopes, moderately eroded. Soil management unit 3bB(IIW).

SbC1 Saverine and Iosco fine sandy loams, 7 to 14 percent slopes, slightly eroded. These soils occur in long narrow areas between nearly level plains and the bottom land along small streams. Soil management unit 3bC(IIIW).

SbC2 Saverine and Iosco fine sandy loams, 7 to 14 percent slopes, moderately eroded. This mapping unit is on the breaks between the nearly level plains and the bottoms of old streams. The lower slopes have many seep spots where the finer textured, underlying material is at or near the surface. Erosion has removed so much material that the plow layer consists mainly of the subsoil. Soil management unit 3bC(IIIW).

SbD1 Saverine and Iosco fine sandy loams, 14+ percent slopes, slightly eroded. These soils are on breaks between the nearly level lake plain and the bottoms of old streams that are cut into the plains. Seep spots are common. The seepage is caused by the horizontal flow of water along the top of the underlying fine-textured horizon. Soil management unit 3bD(IVE).

SbD2 Saverine and Iosco fine sandy loams, 14+ percent slopes, moderately eroded. Erosion has removed so much material that the subsoil is now exposed. Soil management unit 3bD(IVE).

Spalding Series

Spalding soils consist of peat that was developed, under very poor drainage, from woody and fibrous organic materials more than 42 inches deep. The water table is at or near the surface. These soils, in most places, are separated from poorly drained mineral soils by shallow organic soils. The native vegetation was mainly leatherleaf, shrubs, and tamarack.

Spalding soils are more acid than Rifle soils and contain more woody material than Greenwood soils.

Profile description of Spalding peat:

01 0 to 5 inches; spongy mosses and peat; brown (10YR 5/3, 7.5YR 5/2, or 5/4, moist); very strongly acid; 3 to 8 inches thick.

02 5 to 20 inches; mixed fibrous and woody peat; yellowish brown (10YR 5/4 or 5/8, moist); slightly decomposed; extremely to strongly acid; 12 to 18 inches thick.

03 20 inches+; coarse, fibrous peat; yellow (10YR 7/6 or 7/8, moist); extremely to strongly acid.

This soil is used for forestry and wildlife habitats and may be a source of commercial peat (fig. 16).

MAPPING UNIT

ScA0 Spalding peat, 0 to 2 percent slopes. Soil management unit Mc-a (VIIIW).

Tappan Series

Tappan soils were developed from calcareous loam materials. These soils are in poorly to very poorly drained depressions that were old lakebeds or recently burned, shallow, muck areas. Undisturbed areas have a layer of organic materials, 2 to 12 inches thick, on the surface. The native vegetation was mainly swamp hardwoods. Elm, ash, swamp white oak, red maple, and basswood were the principal trees.

The Tappan soils are generally associated with the poorly to very poorly drained Parkhill soils and with organic soils. In the Tappan soils, calcareous material is at or near the surface, but, in Parkhill soils, this material is at greater depths. The Tappan soils have loam till parent material, and the Bach soils, stratified silt and very fine sand.

Profile description of a Tappan loam:

A_p 0 to 8 inches; loam; very dark gray (10YR 3/1, moist); weak, medium, granular structure; friable when moist and soft when dry; mildly alkaline to calcareous; 6 to 9 inches thick.

GC 8 to 15 inches; loam; gray to grayish brown (2.5Y 5/0 to 5/2, moist); weak, coarse, granular structure to weak, medium, subangular blocky structure; friable when moist and soft when dry; calcareous; 6 to 8 inches thick.

CG 15 to 25 inches; fine loam; gray (2.5Y 5/0, moist), mottled with yellowish brown (10YR 5/4, moist); moderate, medium, subangular blocky structure; friable to firm when moist and slightly hard when dry; calcareous; 8 to 11 inches thick.

C_2 25 inches+; loam; light brownish gray (2.5Y 6/2, moist), mottled with dark yellowish brown (10YR 4/4, moist); plastic when wet and friable to firm when moist; calcareous.

Calcareous material is at or within 10 inches of the surface. The parent materials vary from unconsolidated loamy till to stratified silt and fine sand. In many places, calcareous shell fragments occur throughout the profile.

Where adequate tile drains have been installed, Tappan soils are used mainly for corn, wheat, oats, dry beans, sugar beets, alfalfa, and clover.

MAPPING UNITS

TaA0 Tappan loam, 0 to 2 percent slopes. Soil management unit 2cA(I).

TbA0 Tappan mucky loam, 0 to 2 percent slopes. The dark-colored surface layer contains a considerable amount of organic materials. Soil management unit 2cA(I).

Tawas Series

Tawas soils consist of muck that was developed from woody and fibrous organic materials. These materials are 12 to 42 inches deep over sand. Tawas soils generally occur either in poorly to very poorly drained depressions or along larger, natural drainageways. The native vegetation was mainly mixed hardwoods and conifers. The second growth is largely alder, willow, and dogwood.

Tawas soils developed from plant materials similar to those in the Carlisle and Rifle soils, but the Carlisle and Rifle soils are more than 42 inches deep over mineral material. The organic materials in the Tawas soils are mainly woody, whereas those in the Adrian soils are mainly fibrous.

Profile description of the Tawas muck:

01 0 to 12 inches; muck and a few remains of woody material; black to very dark brown (10YR 2/1 to 2/2, moist); strong, medium, granular structure; friable; medium acid to neutral; 8 to 15 inches thick.

02 12 to 20 inches; woody peat; very dark brown (10YR 2/2, moist); fairly well disintegrated; pulpy; medium acid; 8 to 30 inches thick.

03 20 inches+; sand; pale brown (10YR 6/3, moist), mottled with brown, yellowish brown, and strong brown (10YR 5/3, 5/4, and 7.5YR 5/6, moist); single grain (structureless); loose; neutral to calcareous.

The surface layer ranges from a muck to a peat; that is, from highly decomposed material to slightly decomposed organic material. The thickness of the organic materials ranges from 12 to 42 inches. In wet periods, the water table is at or near the surface.

Most of this soil is in permanent pasture or in second-growth forest. Areas that are cleared and adequately drained are used for specialized crops and field crops.

MAPPING UNIT

TcA0 Tawas muck, 0 to 2 percent slopes. Soil management unit M/4c(IVW).

Thomas Series

In the Thomas series are poorly to very poorly drained soils that were developed from clay loam to silty clay loam parent materials. These soils are calcareous at the surface or at depths of less than 10 inches. Calcareous shell fragments are common on the surface and through the soil profile. In undisturbed areas, a layer of organic material, 2 to 12 inches thick, has accumulated on the surface. The native vegetation was mainly swamp hardwoods but included sedges and bluejoint in open areas.

Profile description of Thomas mucky silt loam:

A_1 0 to 6 inches; mucky silt loam; very dark gray to dark gray (2.5Y 3/0 to 10YR 3/1 and 4/1, moist); moderate, fine, granular structure; friable when moist and soft when dry; mildly alkaline to calcareous; 6 to 9 inches thick.

GC 6 to 16 inches; silty clay loam; dark gray to very dark gray (5Y 4/1 to 2.5YR 3/0, moist); moderate, medium, granular structure; slightly sticky when wet and friable when moist; calcareous; 6 to 16 inches thick.

CG 16 inches+; silty clay loam to clay loam; light olive gray, gray, or yellowish brown (5Y 6/2, 10YR 5/1, or 5/8, moist); moderate, medium to coarse, blocky structure; sticky when wet and firm when moist; calcareous.

Where the soil is plowed, the mucky accumulation on the surface is mixed with the underlying mineral layers. The prominence of mottling varies considerably in the lower horizons.

Adequately drained areas are mainly in corn, oats, dry beans, sugar beets, and hay. Some areas are in permanent pasture or farm woodlots. The main problems of management are the lack of outlets for tile drains, the need for plant nutrients, especially manganese and boron, and the maintenance of soil structure.

MAPPING UNIT

TdA0 Thomas mucky silt loam, 0 to 2 percent slopes. Soil management unit 2cA(I).

Tobico Series

Tobico soils occur in small, scattered areas in nearly level depressions that are on broad outwash plains. These soils are poorly to very poorly drained and were developed on waterlogged, mildly alkaline to calcareous sands. They are calcareous at depths of 10 inches or less. In undisturbed areas, a layer of organic material, 2 to 12 inches thick, has accumulated on the surface. This organic material is not mixed or is only slightly mixed with the underlying mineral material. The native vegetation was mostly second growth that consists mainly of willow, alder, aspen, and red maple but included marsh grasses and sedges.

In reaction, Tobico soils differ from Roscommon soils, which are slightly acid to neutral in the upper horizons.

Profile description of Tobico mucky loamy sand:

A_1 0 to 3 inches; mucky loamy sand; black (10YR 2/1, moist); weak, fine, granular structure; friable when moist and soft when dry; many fibrous roots often present; calcareous; 2 to 12 inches thick.

GA 3 to 8 inches; sand; grayish brown (10YR 5/2, moist); single grain (structureless); loose; calcareous; 4 to 8 inches thick.

GC 8 to 18 inches; sand; very pale brown to light gray (10YR 7/3 to 7/2, moist); single grain (structureless); loose; calcareous; 8 to 12 inches thick.

C_g 18 to 30 inches; sand; very pale brown (10YR 7/3, moist), mottled with yellow (10YR 7/6, moist); single grain (structureless); loose; calcareous; 10 to 15 inches thick.

C 30 inches+; waterlogged sand; light gray (10YR 7/1, moist); single grain (structureless); loose; calcareous.

The prominence of the mottles varies considerably in the C_g horizon.

Tobico soil is in pasture and second-growth forest. Because it is wet and sandy, it is poorly suited to field crops.

MAPPING UNIT

TeA0 Tobico mucky loamy sand, 0 to 2 percent slopes. Soil management unit 5cA(IVW).

Tonkey Series

Tonkey soils are poorly to very poorly drained and were developed on stratified sands and gravel, loamy sands, and sandy loams. The native vegetation was mainly elm, ash, red maple, and basswood but included some conifers. Tonkey soils are in the natural toposequence that includes the imperfectly drained Richter soils.

Profile description of a Tonkey sandy loam:

A_p 0 to 8 inches; sandy loam; black to very dark gray (10YR 2/1 to 3/1, moist); weak to moderate, fine to medium, granular structure; friable when moist and slightly hard when dry; neutral to mildly alkaline; 7 to 11 inches thick.

GA 8 to 14 inches; loamy sand; dark grayish brown to light brownish gray (10YR 4/2 to 6/2, moist); weak, fine, granular structure to single grain (structureless); very friable when moist and soft when dry; neutral to mildly alkaline; 3 to 8 inches thick.

GB 14 to 28 inches; loam to sandy clay loam; pale brown to dark grayish brown (10YR 6/3 to 4/2, moist), mottled with strong brown and brownish yellow (7.5YR 5/6 and 10YR 6/8, moist); weak to moderate, medium, subangular blocky structure; sticky when wet and firm when moist; mildly alkaline to calcareous; 7 to 20 inches thick.

C 28 inches+; sand and gravel with layers and lenses of sandy loam, loam, silt, and very fine sand; gray to light gray (10YR 5/1 to 6/1, moist); stratified; lenses vary in thickness; mottling ranges from faint to prominent; structure and consistence vary with textures; calcareous.

The texture of the surface layer ranges from sandy loam to loam. In some undisturbed areas, from 2 to 12 inches of peat or muck is on the surface. Some areas have enough boulders on the surface to interfere with cultivation. In places, stones and boulders are present throughout the profile.

Where tile and surface drains are adequate, this soil is used mainly for corn, wheat, oats, sugar beets, field beans, alfalfa, and clover. Some areas that originally had a shallow surface layer of organic materials have been burned over and are in permanent pasture.

MAPPING UNIT

TfA0 Tonkey sandy loam, 0 to 2 percent slopes. Soil management unit 3cA(IIW).

Tonkey and Bach Series

Where they are closely associated in Sanilac County, Tonkey and Bach soils are mapped together as an undifferentiated unit. These soils are poorly to very poorly drained. The Bach soils were developed on calcareous, stratified lacustrine deposits of very fine sand and silt, with some clay. Bach soils are calcareous at or within 10 inches of the surface. The Tonkey soils were developed on stratified sands, loamy sands, sandy loams, and gravel in which there are lenses of finer textured material. The native vegetation on these soils was mainly elm, ash, red maple, and basswood but included some conifers.

Tonkey and Bach soils were developed from stratified parent materials, and the Tappan soils, from less stratified loam materials.

In their respective series descriptions, profiles of a Tonkey soil and a Bach soil are described.

Where surface and tile drains are adequate, Tonkey and Bach soils are used mainly for corn, wheat, oats, field beans, alfalfa, and clover.

MAPPING UNITS

TgA0 Tonkey and Bach fine sandy loams, 0 to 2 percent slopes. Some areas that have a silt loam plow layer are included in this mapping unit. Soil management unit 3cA(IIW).

TgB1 Tonkey and Bach fine sandy loams, 2 to 7 percent slopes, slightly eroded. Some areas that have a silt loam plow layer are included in this mapping unit. Soil management unit 3cA(IIW).

Tyre Series

Tyre loamy sands and Tyre sandy loams are mapped together in Sanilac County as an undifferentiated unit. These soils are imperfectly drained in most places but are moderately well drained in the more sloping areas. They were developed from sandy glacial deposits that are 18 to 42 inches deep over sandstone bedrock. The native vegetation consisted of hardwoods and some white pine. The hardwoods were mainly elm, ash, and sugar maple.

Profile description of a Tyre loamy sand:

A_1 0 to 3 inches; loamy sand; very dark gray (10YR 3/1, moist); weak, fine, granular structure; very friable when moist and soft when dry; slightly acid; 1 to 5 inches thick.

AB_{bg} 3 to 8 inches; loamy sand; light brownish gray (10YR 6/2, moist), mottled with yellowish brown (10YR 5/8, moist); single grain (structureless) to weak, fine, granular structure; loose; slightly acid; 4 to 6 inches thick.
D_1 8 to 24 inches; sandstone fragments and loamy sand; light gray (10YR 7/2, moist); single grain (structureless); loose; slightly acid; 12 to 24 inches thick.
D_2 24 inches+; Marshall sandstone bedrock.

The depth to the Marshall sandstone generally ranges from 18 to 42 inches, but some areas are shallower than 18 inches and some areas are deeper than 42 inches.

Most of the acreage of Tyre soils is in permanent pasture and second-growth woodland. A small acreage is in field crops.

MAPPING UNITS

ThA0 Tyre loamy sand and sandy loam, 0 to 2 percent slopes. Soil management unit 4/Rb(IVW).
ThB1 Tyre loamy sand and sandy loam, 2 to 6 percent slopes, slightly eroded. Soil management unit 4/Rb(IVW).
ThC1 Tyre loamy sand and sandy loam, 6 to 12 percent slopes, slightly eroded. These soils are moderately well drained where they are deep to bedrock. Soil management unit 4/Rb(IVW).

Wallkill Series

The Wallkill soils were developed from slightly acid to mildly alkaline mineral overwash materials that are of variable thickness over organic soils or are mixed with them. These soils occur in irregularly shaped depressions adjacent to sloping upland soils that have been cultivated and are moderately to severely eroded. Wallkill soils are poorly to very poorly drained, and the water table is normally at or near the surface in wet seasons.

These soils differ from Washtenaw soils, which developed from overwash that was deposited on mineral materials instead of organic materials.

Profile description of Wallkill loam:

+1 0 to 7 inches; loam; grayish brown to light brownish gray (10YR 5/2 to 6/2, moist); weak, fine, granular structure; friable when moist; organic content variable but usually low; slightly acid to neutral; 3 to 12 inches thick.
+2 7 to 15 inches; loam to silt loam; light brownish gray (10YR 6/2, moist), mottled with pale yellow and pale brown (2.5Y 7/4 and 10YR 6/3, moist); weak, fine, granular structure to weak, thin, platy structure; friable when moist; slightly acid to mildly alkaline; 5 to 30 inches thick.
01 15 inches+; black to very dark gray (10YR 2/1 to 3/1, moist) muck or brown (10YR 5/3, moist) peat; muck grades with increasing depth to fibrous peat.

The mineral overwash material ranges in thickness from 4 inches to about 40 inches. The texture of the surface layer ranges from a sandy loam to silt loam.

Where drained, this soil is used in the same way as are adjoining upland soils. The undrained areas are used mostly for permanent pasture or are idle.

MAPPING UNIT

WoA0 Wallkill loam, 0 to 2 percent slopes. Soil management unit L2c(IIIW).

Warners Series

Warners muck and Marl are mapped together as an undifferentiated unit in Sanilac County. On cultivated areas the muck is mixed with the marl. Warners soils are very poorly drained. They consist of black muck and gray mineral material that together are less than 12 inches thick over gray or white marl. In some places the marl is at the surface. The native vegetation was elm, ash, willow, red maple, and some conifers.

The Warners muck has shallower organic materials than the Edwards muck, which is underlain by marl at depths of 12 to 42 inches.

Profile description of Warners muck:

01 0 to 7 inches; black (10YR 2/1, miost); granular muck; contains various amounts of gray to light gray (10YR 6/1, moist) marl and other mineral materials; mildly acid to strongly alkaline; 5 to 10 inches thick.
D_1 7 to 12 inches; dark gray to gray (10YR 4/1 to 5/1, moist); marl lenses or streaks of black or very dark gray muck; calcareous; 3 to 10 inches thick.
D_2 12 inches+; gray to light gray (10YR 6/1 to 7/1, moist); marl containing numerous shell fragments.

In cultivated areas the mucky material is mixed with marl and the plow layer contains a large amount of marl material. In some areas the surface layer is largely marl and contains little or no organic material. The water table is at or near the surface.

This mapping unit is chiefly in permanent pasture or second-growth forest. A few areas that have been cleared are used for truck crops and field crops.

MAPPING UNIT

WbA0 Warners muck and Marl, 0 to 2 percent slopes. Soil management unit M/mc(IVW).

Washtenaw Series

Washtenaw soils were developed from slightly acid to neutral, recently deposited, mineral overwash materials, of variable thickness, that overlie poorly drained mineral soils. These soils are in sloping areas in depressions that have no outlets. They are imperfectly to very poorly drained. The medium- to fine-textured materials that washed from adjacent slopes make up most of the deposited materials. These accumulations are 8 to 42 inches thick. Where these soils are too wet to be cultivated, the vegetation is mostly marsh grasses or shrubs.

Profile description of a Washtenaw silt loam:

+1 0 to 7 inches; silt loam; grayish brown to light brownish gray (10YR 5/2 to 2.5Y 6/2, moist); weak, fine, granular structure; friable when moist; content of organic matter varies; slightly acid; 6 to 12 inches thick.
+2 7 to 20 inches; loam to silt loam; light brownish gray (10YR 6/2, moist), mottled with gray and pale yellow (10YR 5/1 and 2.5Y 7/4, moist); stratified; friable when moist; slightly acid to neutral; 3 to 30 inches thick.
A_{1b} 20 inches+; sandy loam to silty clay loam; very dark gray to dark gray (10YR 3/1 to 4/1, moist); moderate, coarse, blocky structure; slightly sticky when wet and firm when moist; relatively high content of organic matter; slightly acid to neutral.

The overwash materials range from sandy loam to silt loam in texture. Runoff is very slow, and many areas are ponded after heavy rains. Because of the lack of outlets, many areas are difficult to drain. These soils are generally used in the same way as adjacent upland soils.

MAPPING UNITS

WcA0 Washtenaw loam and silt loam, 0 to 2 percent slopes. Soil management unit L2c(IIIW).
WcB0 Washtenaw loam and silt loam, 2 to 6 percent slopes. Soil management unit L2c(IIIW).

WdA0 Washtenaw sandy loam and loam, 0 to 2 percent slopes. Soil management unit L2c(IIIW).

WdB0 Washtenaw sandy loam and loam, 2 to 6 percent slopes. Soil management unit L2c(IIIW).

Willette Series

Willette soils consist of well-decomposed organic materials that are 12 to 42 inches deep over clay to silty clay. The plants that make up the organic material were mostly woody. These soils are poorly to very poorly drained. They are in depressions, along large drainageways, or in isolated depressions in areas of greater relief. The native vegetation was mixed swamp hardwoods and conifers. Cutover and burned areas now support stands of alder, willow, and dogwood.

Willette soils are shallower to the underlying mineral material than the Carlisle and Rifle soils. They are underlain by finer textured mineral material than are the Linwood and Tawas soils.

Profile description of Willette muck:

01 0 to 8 inches; woody muck; very dark grayish brown (10YR 3/2, moist); well decomposed; moderate, medium, granular structure; soft; slightly acid; 8 to 12 inches thick.

02 8 to 15 inches; woody peat; dark brown (7.5YR 3/2, moist); well disintegrated; medium to slightly acid; 5 to 10 inches thick.

03 15 to 20 inches; mixture of woody and fibrous peat; brown and dark yellowish brown (7.5YR 5/2 to 10YR 4/4, moist); slightly to medium acid; 5 to 10 inches thick.

04 20 to 25 inches; sedimentary peat; dark reddish brown (5YR 3/2 to 3/4, moist); gelatinous; slightly acid; 2 to 6 inches thick.

D 25 inches+; silty clay; light gray (2.5Y 7/2, moist); massive (structureless); firm when moist and very hard when dry; calcareous.

The peat varies considerably in degree of disintegration. In wet periods the water table is at or near the surface.

Willette muck is mostly in permanent pasture or in second-growth forest. A few cleared and drained areas are used for special crops and field crops.

MAPPING UNIT

WeA0 Willette muck, 0 to 2 percent slopes. Soil management unit M/1c(IIIW).

Use and Management of Soils[4]

A farmer should know his soils if he is to manage them successfully and obtain high yields year after year. He should have some knowledge of the chemical and physical properties of the soils as far down as roots penetrate, and also of the slope, degree of erosion, and other characteristics visible at the surface. The soils ought to be studied so that their water relations are known as well as their needs for plant nutrients and tillage. It is important to know the kinds of fertilizer to use, the crops that can be profitably grown, and the cultural practices to use.

Soils differ in texture, drainage, topography, content of organic matter, and other characteristics. These differences cause variations in productivity and in suitability for specific crops. The differences among soils must be considered when a system of soil management is selected.

This section consists of four main parts. In the first part, general practices of soil management are discussed. In the second part, the nationwide system of land capability classification is described. The third part explains a system of placing soils in management groups and units according to specific soil characteristics that are important in use and management and of denoting these by connotative symbols. In the fourth part are recommendations for management of soil management groups and units.

General Practices of Soil Management

Soils should be managed under a program that provides (1) maintenance of organic matter; (2) suitable cropping systems; (3) adequate fertilization and liming; (4) proper tillage and seeding; (5) artificial drainage; and (6) erosion control.

Maintenance of organic matter

The well-drained mineral soils in the county contain only a small or medium amount of organic matter. If these soils are to be productive for a long period, additional organic matter must be supplied.

Organic matter generally is supplied by additions of barnyard manure and by the roots, stubble, and crop residues that are left after harvesting. But most farms in the county do not have enough barnyard manure to supplement crop residues. Additional organic matter should be supplied in other ways.

Farmers in the county have found that a catch crop will help supply the needed organic matter. Sweetclover and clover are satisfactory catch crops on medium to moderately fine textured soils that contain enough lime to grow legumes. The clover is ordinarily seeded with a small grain and plowed under in spring before a cultivated crop is planted. On the coarser textured soils, rye is frequently seeded in fall and plowed under the following spring; then a cultivated crop is planted. On most soils, legume-and-grass crops add organic matter and improve the structure of the soil.

Suitable cropping systems

A good cropping system is one that combines soil-depleting and soil-building crops in such a way that production is kept at a high level. Corn, field beans, sugar beets, and other row crops are soil-depleting crops; they use a large amount of the plant nutrients in the soil. Unless these nutrients are replaced, the crops that follow the soil-depleting crops have reduced yields. Alfalfa, clover, and other close-growing legumes may increase the yields of crops that follow them. This is partly because these legumes add nitrogen to the soil. Legumes, however, draw heavily on mineral nutrients, which should be replaced by fertilizer and manure.

If production is to be kept at a high level, a cropping system that protects the soil from erosion should be used. Table 4 lists the relative protectiveness of different cropping systems in values that range from 20 for the least protective system to 99 for the most protective system.

[4] This section was written by I. F. SCHNEIDER, J. R. GUTTAY, R. L. COOK, and R. LUCAS, Michigan State University, and C. A. ENGBERG, Soil Conservation Service.

TABLE 4.—*Cropping systems and their relative protectiveness*[1]

[A, legume-grass; gm, green manure; O, spring grain; R, row crop; W, winter grain; (fc), field cultivator used]

Cropping system	Relative protectiveness	Cropping system	Relative protectiveness
R	20	AARWgmRW	78
RgmR	28	ARO	78
Rgm	36	AROW	79
RRO	39	AARgmRO	79
RRW	42	AROgmW	80
RWRRO	44	AARgmRW	80
RO	48	AAARRO	80
RgmROgm	50	ARW	81
RW	53	AAWRO	82
RgmRWgm	53	AAROO	84
RWgmRgmROgm	55	AAWgmRO	84
ROO	55	AAROgmO	85
ROgm	57	AAROW	85
RWgm	61	AARO	86
ROgmOgm	64	AAROgmW	86
ARORO	66	AARW	87
ARORW	68	AAAROW	88
ARROW	69	AWO	88
AROgmRO	69	AAARO	88
ARWRW	70	AAARW	90
AROgmRW	71	AAAARO	91
ARWgmRW	72	AAAARW	91
ARgmROgmW	72	AAWO	92
AARORO	73	AO	92
AARORW	75	AAOW	93
AAROgmRO	76	AAAWO	93
AARRO	77	AW	94
AROO	77	AAO	96
AARROW	77	AAW	97
AAROgmRW	77	AA(fc)O	98
AROgmO	78	AA(fc)W	98
AARRW	78	A	99

[1] Values in this table are based on ready reference prepared by the Soil Conservation Service.

In determining the values of relative protectiveness, it was assumed that all crop residues are plowed into the soil immediately before another crop is planted. The values in table 4 must be reduced if the plant residues are removed or if they are plowed under long before a crop is planted. Therefore, in rotations that consist of row crops and small grains, 15 must be subtracted from the value given. In rotations that include alfalfa, 3 must be subtracted for each row crop.

Under minimum tillage, more intensive cropping systems can be used than with conventional tillage operations.

Fertilization and liming

The ratio and grade of a fertilizer and the rate of application should be based on the results of soil tests (*11*). The samples tested should be representative of the field where the fertilizer is to be applied. Procedures for taking samples correctly are described in the Michigan State University Extension Folder F–278 (*9*).

The moderately fine and fine textured soils generally contain larger quantities of potassium than phosphorus and need a fertilizer that contains twice as much phosphoric acid as potash. The coarse-textured, or sandy, soils and the mucks generally need a fertilizer high in potash.

Fertilizer ratios, grades, and rates of application for named crops are recommended for the mineral soil management groups in Sanilac County. These recommendations are in tables that are found in the subsection, Management by Groups and Units.

Farm manure is a source of plant food and of organic matter as well. The manure should be stored, reinforced, and applied with care.

Lime is generally needed on the sandier upland soils in the county. If sufficient lime is not supplied, the seedings of alfalfa and clover may be unsuccessful. Table 5 gives general quantities of ground limestone that should be applied to the light-colored soils in the county. The quantities of lime needed are given according to the pH, which is determined by tests, and by texture of the plow layer. If marl, sugar-factory lime, basic slag, or other liming materials are used, the limestone equivalent of the material should be determined. The rate of application should be adjusted according to the limestone equivalent and the results of soil tests. More exact quantities than those in table 5 can be determined from the results of soil tests made at the county soil-testing laboratory.

TABLE 5.—*Ground limestone recommended to be applied on light-colored soils according to the reaction and texture of the plow layer*

Reaction (pH) of plow layer	Tons per acre on—		
	Sands and loamy sands	Sandy loams and loams	Clay loams and clays
Very strongly acid (4.3–5.0)	3.5–4.5	4.5–5.5	5.5–7.0
Strongly acid (5.0–5.5)	2.5–3.5	3.5–4.5	4.5–5.5
Medium acid (5.5–6.0)	1.5–2.5	2.5–3.5	3.0–4.5
Slightly acid (6.0–6.7)	1.0–1.5	1.0–2.0	1.5–2.5

Tilling and seeding

Tilling causes the most important physical change that is made in a soil when it is cultivated. The surface soil is loosened when crop residues are turned under and when weeds are controlled by tillage. The loosened surface soil permits easier penetration by plant roots and permits an increased intake of air and water.

In some places, however, excessive disking, dragging, and harrowing have packed the soil so much that most of the advantages of plowing have been lost. Soils should not be plowed when they are so wet that they puddle. Plowing a soil when it is wet may cause damage that lasts for years. Tilling operations that are not needed do not increase yields; they increase costs.

After a good job of plowing, little additional tillage is needed. The soil may be leveled by trailing directly behind the plow a spike-tooth harrow or other light tillage implement. The seedbed can be made sufficiently firm by press wheels or by a cultipacker pulled behind the drill. With minimum tillage (*4*), more moisture is absorbed and runoff and water erosion are lessened.

Plowing and immediate planting are suggested for oats, barley, sugar beets, and corn but not for wheat and summer seedings of alfalfa. For field beans and soybeans, plowing and immediate planting may not be advisable.

Alfalfa seeded in winter wheat should be drilled in spring after the soil has thawed and dried. If seeded in spring grain, alfalfa or clover should be seeded in bands. Sweet clover and mixtures of clover, such as sweet clover and mammoth clover, are suitable for use as green-manure crops. Green-manure crops can be seeded in corn by using a grass-seed box mounted on the cultivator. The seeding is done during the last cultivation of the corn. If the corn rows are wide, a narrow seed drill can be used instead of a cultivator.

Drainage

Drainage is the main problem of management on the level, poorly drained soils and on some of the imperfectly drained soils. If adequate surface drainage and tile drainage are not provided, spring crops must be planted late, and yields are low. Crops, particularly those that take a long time to mature, do not have enough time to grow and produce high yields. Crops may be damaged by flooding when the rainfall is heavy in summer and early in fall. Field crops often have shallow roots because drainage is poor, but yields can be increased by an adequate drainage system. Serious damage may occur during periods of drought when the natural water table is lowered too much in either the coarse-textured mineral soils or the organic soils.

Controlling erosion

On sloping soils that are cultivated, the hazard of water erosion is reduced by tilling on the contour, strip-cropping, terracing, and keeping the natural waterways in grass. Windbreaks and windstrips reduce the hazard of wind erosion on the organic soils.

Capability Grouping of the Soil Conservation Service[5]

Capability grouping is a system of classification used to show the relative suitability of soils for crops, pasture, forestry, and wildlife cover. It is a practical grouping based on the needs and limitations of the soils, on the risks of damage to them and the crops growing on them, and also on the response to management. There are three levels above the soil mapping unit in this system. They are the capability unit, subclass, and class.

The capability unit, which also can be called a soil management unit, is the lowest level of the capability grouping. A capability unit is made up of soils similar in kind of management they need, in risk of damage, and in general suitability for use.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "E" indicates that the main limiting factor is risk of water erosion if the plant cover is not maintained; "W" means that excess water retards plant growth or interferes with cultivation unless the soils have been artificially drained; and "S" shows that the soils are droughty, or unusually low in fertility.

The broadest grouping, the capability class, is identified by Roman numerals from I through VIII. All the soils in one capability class have limitations and management problems of about the same degree, but of different kinds, as shown by the subclass. All the land capability classes except class I may have one or more capability subclasses.

In classes I, II, and III are soils that are suitable for annual or periodic cultivation of annual or short-lived crops.

Class I soils are those that have the widest range of use and the least risk of damage. They are level, or nearly level, productive, either well-drained or easily drained, and easy to work. They can be cultivated with almost no risk of water and wind erosion and will remain productive if managed with normal care.

Class II soils can be cropped regularly but do not have quite so wide a range of suitability as class I soils. Some class II soils are gently sloping; consequently, they need moderate care to prevent erosion. Other soils in class II may be slightly droughty.

Class III soils can be cropped regularly but have a narrower range of use than class II soils. They need even more careful management.

In class IV are soils that should be cultivated only occasionally or only under very careful management.

In classes V, VI, and VII are soils that normally should not be cultivated for annual or short-lived crops, but they can be used for pasture or range, as woodland, or for wildlife cover.

Class V soils are nearly level or gently sloping but are droughty, wet, low in fertility, or otherwise unsuitable for cultivation.

Class VI soils are not suitable for crops, because they are steep or droughty or otherwise limited, but they give fair yields of forage or forest products. Some soils in class VI can, without damage, be cultivated enough so that fruit trees or forest trees can be set out or pasture crops seeded.

Class VII soils provide only poor to fair yields of forage or forest products and have characteristics that limit them severely for these uses.

Class VIII soils have practically no agricultural value. Some areas are used as watersheds, as wildlife habitats, or for scenery.

The designations of the soil management units in this report have been worked out cooperatively by the Soil Conservation Service, the Michigan Agricultural Experiment Station, and the Cooperative Extension Service in Michigan. They consist of symbols, such as 2aA, 2aB, and 4bA, combined with the symbols for the capability classes and subclasses of the Soil Conservation Service. The symbols 2aA, 2aB, 4bA, and other similar symbols are explained in the third part of this section.

In the outline that follows are brief descriptions of the soils that make up the classes, subclasses, and the soil management units in Sanilac County.

[5] This subsection was prepared by C. A. ENGBERG, State Soil Scientist, Soil Conservation Service, United States Department of Agriculture. The rest of this report was prepared cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station, Michigan State University.

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Class I.—Deep, nearly level, productive soils that have few or no limitations that restrict their use.

2aA(I).—Nearly level, slightly eroded, light-colored, medium-textured, well-drained soils.

2bA(I).—Nearly level, moderately dark colored, medium-textured soils formed under imperfect drainage.

2cA(I).—Nearly level to gently sloping, dark-colored, medium-textured soils developed under poor drainage.

Class II.—Soils that have some limitations that reduce the choice of plants or require some conservation practices.

Subclass IIE.—Soils that are likely to erode if not protected.

2aB(IIE).—Nearly level to gently sloping, slightly to moderately eroded, light-colored, medium-textured, well-drained soils.

Subclass IIW.—Soils in which excess water may restrict the choice of crops or require some corrective measures.

2bB(IIW).—Gently to moderately sloping, slightly to moderately eroded, moderately dark colored, medium-textured soils formed under imperfect drainage.

2cA(IIW).—Nearly level, dark-colored, moderately fine textured soil developed under poor drainage.

3bA(IIW).—Nearly level, moderately dark colored, moderately coarse textured soils formed under imperfect drainage.

3bB(IIW).—Gently sloping, slightly to moderately eroded, moderately dark colored, moderately coarse textured soils formed under imperfect drainage.

3cA(IIW).—Nearly level to gently sloping, dark-colored, medium to moderately coarse textured soils developed under poor drainage.

M/3c(IIW).—Level, dark-colored, very poorly drained organic soils with coarse- to medium-textured mineral materials at depths of 12 to 42 inches.

Subclass IIS.—Soils that have moderate limitations of moderate moisture-holding capacity or an erosion hazard.

3aA(IIS).—Nearly level, slightly eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.

3aB(IIS).—Gently sloping, slightly to severely eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.

Class III.—Soils that have severe limitations that require special conservation practices.

Subclass IIIE.—Soils that will erode if not protected.

2aB(IIIE).—Gently sloping, severely eroded, light-colored, medium-textured, well-drained soils.

2aC(IIIE).—Moderately sloping, slightly to moderately eroded, light-colored, medium-textured, well to moderately well drained soils.

Class III—Continued

Subclass IIIW.—Soils that may be severely limited by excess water.

3bC(IIIW).—Moderately sloping, slightly to moderately eroded, moderately dark colored, moderately coarse textured soils formed under imperfect drainage.

4bA(IIIW).—Nearly level, light to moderately dark colored, coarse-textured soils formed under good to imperfect drainage.

4bB(IIIW).—Gently sloping, slightly eroded, light to moderately dark colored, coarse-textured soils formed under good to imperfect drainage.

4cA(IIIW).—Nearly level, dark-colored, coarse to moderately coarse textured soils formed under poor drainage.

4cB(IIIW).—Gently sloping, slightly eroded, dark-colored, coarse to moderately coarse textured soils formed under poor drainage.

L3b(IIIW).—Level to gently sloping, moderately dark colored, imperfectly to moderately well drained sandy loam alluvial soils.

L2c(IIIW).—Nearly level to gently sloping, dark-colored, moderately coarse to moderately fine textured alluvial soils developed under poor drainage.

Mc(IIIW).—Level, very poorly drained, deep organic soils, well to moderately well supplied with bases.

M/1c(IIIW).—Level, dark-colored, very poorly drained organic soil with fine-textured mineral materials at depths of 12 to 42 inches.

Subclass IIIS.—Soils that have severe limitations because of low fertility or low moisture-holding capacity, or wind and water erosion hazard, or a combination of these.

3aC(IIIS).—Moderately sloping, slightly to severely eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.

4aA(IIIS).—Nearly level, slightly eroded, light-colored, coarse-textured, well-drained, droughty soils.

4aB(IIIS).—Gently sloping, slightly to moderately eroded, light-colored, coarse-textured, well-drained, droughty soils.

4aC(IIIS).—Moderately sloping, slightly to moderately eroded, light-colored, coarse-textured, well-drained, droughty soils.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVE.—Soils that will erode if not protected.

2aC(IVE).—Moderately sloping, severely eroded, light-colored, medium-textured, well-drained soils.

2aD(IVE).—Strongly sloping, slightly to moderately eroded, light-colored, medium-textured, well to moderately well drained soils.

3bD(IVE).—Strongly sloping, slightly to moderately eroded, moderately dark colored, mod-

Class IV—Continued
Subclass IVE—Continued
erately coarse textured soils formed under imperfect drainage.
Subclass IVW.—Soils that have very severe limitations because of excess water.
4/Rb(IVW).—Nearly level to moderately sloping, slightly eroded, moderately dark colored, moderately well to imperfectly drained soils with sandstone bedrock at depths of 18 to 42 inches.
5bA(IVW).—Nearly level to gently sloping, moderately dark colored sands developed under imperfect drainage.
5cA(IVW).—Nearly level, dark-colored sands formed under poor drainage.
M/mc(IVW).—Level, dark-colored, very poorly drained organic soils less than 42 inches deep over marl.
M/4c(IVW).—Level, dark-colored, very poorly drained organic soils with coarse-textured materials at depths of 12 to 42 inches.
Subclass IVS.—Soils that have very severe limitations of low fertility, low moisture-holding capacity, erosion, or a combination of these.
3aD(IVS).—Strongly sloping, slightly to moderately eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.
4aD(IVS).—Strongly sloping, slightly to moderately eroded, light-colored, coarse-textured, well-drained, droughty soils.
5aA(IVS).—Nearly level, slightly eroded, light-colored, well to moderately well drained, very droughty sands.
5aB(IVS).—Gently sloping, slightly eroded, light-colored, well to moderately well drained, very droughty sands.
5aC(IVS).—Moderately sloping, slightly eroded, light-colored, well-drained, very droughty sands.
Class V.—Soils that have little or no erosion hazard, but have other limitations that make them generally unsuitable for cultivation and limit their use to pasture, woodland, or wildlife cover.
Subclass VW.—Soils that are permanently wet or highly susceptible to flooding.
L3c(VW).—Level to gently sloping, dark-colored, moderately coarse to medium-textured alluvial soils developed under poor drainage.
Class VI.—Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture, woodland, or wildlife cover.
Subclass VIE.—Soils that are highly susceptible to erosion.
2aD(VIE).—Strongly sloping, severely eroded, light-colored, medium-textured, well-drained, soils.
2aE(VIE).—Steep, slightly to severely eroded, light-colored, medium-textured, well-drained, soils.

Class VI—Continued
Subclass VIS.—Soils that have severe limitations of low fertility and moderately low moisture-holding capacity.
3aE(VIS).—Strongly sloping or steep, moderately or severely eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils.
Class VII.—Soils unsuitable for cultivation and with very severe limitations that restrict their use largely to pasture, woodland, or wildlife cover.
Subclass VIIS.—Soils that have very severe limitations because of low fertility or low moisture-holding capacity, or wind and water erosion, or a combination of these.
4aE(VIIS).—Steep, slightly to severely eroded, light-colored, coarse-textured, well-drained, droughty soils.
5aD(VIIS).—Strongly sloping to steep, slightly to severely eroded, light-colored, well-drained, very droughty sands.
5.3aA(VIIS).—Nearly level to gently sloping, slightly eroded, light-colored, well to imperfectly drained, extremely droughty sands.
5.3aC(VIIS).—Gently sloping to steep, slightly to severely eroded, light-colored, well-drained, extremely droughty sands.
Class VIII.—Soils not suitable for the commercial production of crops, grasses, or trees.
Subclass VIIIW.—Soils not suited to commercial plants, because of excess water.
Mc-a(VIIIW).—Level, very poorly drained, deep, raw, acid peats.
Subclass VIIIS.—Soils not suited to commercial plants because of varied limitations.
S(VIIIS).—Miscellaneous land types.

Soil Management Groups and Units

This subsection explains how the soils are grouped for easy reference to their management needs and potentials. Soils in a similar position on the landscape, made up of similar materials, having about the same degree of natural drainage, and having similar soil qualities are called a management group. Some of the management groups are subdivided into management units according to percentage of slope and degree of erosion. Other management groups consist of level or nearly level soils, and a management unit in one of these groups consists of the same soils as the group. Soils in a management unit are enough alike to be suitable for the same crops and cropping systems, to have about the same needs for management of soil and control of water, and to respond similarly to treatment. Management units are the same groups of soils as the capability units described in the subsection on capability grouping.

Table 6 shows the relationships among soil management groups in Sanilac County.

For groups of mineral soils on uplands, the dominant, overall average textural class of soil material is given a number: 2, clay loam, silt loam, or loam; 3, sandy loam; 4, loamy sand; 5, sand; and 5.3, extremely droughty sand. Natural drainage is shown by a small letter: a, well or moderately well drained; b, imperfectly drained; and c,

poorly or very poorly drained. The symbol 2a thus designates a group of upland soils that developed from loam, silt loam, or clay loam parent materials that are well drained or moderately well drained.

TABLE 6.—*Relationships of soil management groups*

Position and texture of parent material	Natural drainage		
	Well or moderately well drained: (a)	Imperfectly drained: (b)	Poorly or very poorly drained: (c)
Upland soils:			
2—Loam, silt loam, or clay loam.	2a	2b	2c.
3—Sandy loam	3a	3b	3c.
4—Loamy sand	4a	4b	4c.
5—Sandy, very droughty	5a	5b	5c.
5.3—Sand, extremely droughty	5.3a		
Lowland soils, L:			
L2—Stratified; moderately coarse to moderately fine textured.			L2c.
L3—Stratified; moderately coarse to medium textured.		L3b	L3c.
Organic soils, M:			
Deep, acidic			Mc–a.
Deep, basic			Mc.
Organic material over clay or silty clay at 12 to 42 inches.			M/1c.
Organic material over marl at 12 to 42 inches.			M/mc.
Organic material over sandy loam or clay loam at 12 to 42 inches.			M/3c.
Organic material over loamy sand at 12 to 42 inches.			M/4c.

Well and moderately well drained soils in this county have a light-colored surface layer and a yellow, brown, or reddish-brown subsoil that is bright colored and nearly free from mottling. Imperfectly drained soils have a darker colored surface layer and a mottled subsoil of mixed yellow, gray, brown, and orange colors. Poorly drained soils have a dark-colored surface layer that, in many places, is mucky; the subsoil is predominantly gray, mottled with brown and orange.

Lowland (Alluvial) mineral soils that consist of stratified layers are given a symbol that begins with an L. To this is added a figure to indicate texture and a small letter to designate the natural drainage.

Organic soils are given symbols that start with the capital letter M. The group of deep, strongly acid organic soils is given the symbol Mc-a. Deep, neutral or only slightly acid soils are given the symbol Mc. Shallow organic soils, which consist of 12 to 42 inches of peat or muck over mineral materials, are grouped by texture or composition of the mineral materials: Over clay, M/1; over marl, M/m, over loam or sandy loam M/3; and over loamy sand or sand, M/4. The small letter "c" is added to all organic soils to indicate they are poorly to very poorly drained.

Many properties of a soil depend on its texture and natural drainage. The descriptive symbols of the soil management groups, therefore, connote some of the properties of the soils in each group.

The moderately fine textured and medium-textured, well-drained soils (management group 2a) can hold more moisture against gravity than the coarse-textured, well-drained soils. Consequently, they are likely to have more moisture available for crops than the coarser textured soils of management group 5a.

The coarse-textured soils (management group 5a) absorb water more rapidly than the finer textured soils and, therefore, lose less water in runoff. But the larger quantity of water that enters the coarse-textured soils removes lime and soluble materials to greater depths. The coarse-textured, or sandy, soils originally contained a smaller amount of available plant nutrients than the fine-textured ones. These sandy soils are better suited to deep-rooted crops or to crops that grow during the moister, cooler parts of the year. Under natural conditions, the sandy, coarse-textured upland soils normally are less fertile than the finer textured, well-drained soils of management group 2a.

The greatest amounts of organic matter accumulated in soils that were formed under poor drainage. Consequently, in soils that formed from parent materials of similar texture, the poorly drained mineral soils are better supplied with organic matter than are the well-drained ones. Organic matter is the natural source of nitrogen in soils; it increases the available moisture-holding capacity. The poorly drained soils, therefore, are naturally better supplied with nitrogen than better drained soils that formed from similar parent materials. They have a higher capacity for holding available moisture than the better drained soils.

Soils that were formed under imperfect and poor drainage normally require artificial drainage before they can be cultivated. These soils receive runoff from adjoining slopes. The coarsest textured soils that need to be drained (management groups 5b and 5c) are so permeable that only ditches may be required. In the finer textured soils, tile lines are usually needed in addition to the ditches. The tile lines should be spaced closer together in the finer textured soils than they are in the coarser textured soils.

Poorly drained mineral soils are slightly acid to moderately alkaline. Even if they are on nearly level to gentle slopes, these poorly drained soils are less acid than the well and moderately well drained soils.

Clay and organic materials hold the mineral soil particles together in clumps, or aggregates, and thereby impart good tilth to the soils. The well-drained, sandy soils contain the least organic matter and clay. Unless they are protected by a vegetative cover or by windbreaks, they are more likely to be moved by water and wind than the finer textured soils.

Because our knowledge concerning the use and management of soils is constantly increasing, the groupings described probably will be changed as more knowledge is gained. Management problems should be analyzed in terms of soil characteristics so that a knowledge of the soils is used as a basis to the solution of the problems.

Soil management units

Most groups of well-drained upland mineral soils are divided into soil management units according to slope and degree of erosion. A capital letter placed after the group

symbol designates the range of slope; for example, the "B" in management group 2aB. The slope ranges are defined in the subsection, Management by Groups and Units.

Table 7 lists the map symbols of each mapping unit in Sanilac County and gives the management unit for each.

TABLE 7.—*Guide to mapping units and soil management units*

Map symbol	Mapping unit described on page—	Soil management unit	Management unit described on page—
AaA0	9	M/4c(IVW)	71
AbA0	9	L3c(VW)	69
AbB0	9	L3c(VW)	69
AcA0	9	L3b(IIIW)	69
AcB0	9	L3b(IIIW)	69
AdA0	9	L3c(VW)	69
AdB0	9	L3c(VW)	69
AeA0	10	5bA(IVW)	67
AeB1	10	5bA(IVW)	67
BaA0	10	3cA(IIW)	58
CaA0	11	2bA(I)	49
CaB1	11	2bB(IIW)	50
CaC2	11	2bB(IIW)	50
CbA0	11	2bA(I)	49
CbB1	11	2bB(IIW)	50
CbB2	11	2bB(IIW)	50
CcA0	11	Mc(IIIW)	72
CdA0	12	Mc(IIIW)	72
Ce	12	S(VIIIS)	72
CfA0	12	3bA(IIW)	56
CfB1	12	3bB(IIW)	57
CgA1	13	5aA(IVS)	65
CgB1	13	5aB(IVS)	65
EaA1	13	5.3aA(VIIS)	68
EaB1	13	5.3aA(VIIS)	68
EaC1	13	5.3aC(VIIS)	68
EbA0	13	5.3aA(VIIS)	68
EbC0	13	5.3aC(VIIS)	68
EcA0	14	4cA(IIIW)	63
EcB1	14	4cB(IIIW)	64
EdA0	14	M/mc(IVW)	71
EeA0	15	4cA(IIIW)	63
EeB1	15	4cB(IIIW)	64
GaC1	15	2aC(IIIE)	47
GaC2	15	2aC(IIIE)	47
GaD2	15	2aD(IVE)	48
GbA0	16	4bA(IIIW)	62
GbB1	16	4bB(IIIW)	63
Gc	16	S(VIIIS)	72
GdA0	16	Mc-a(VIIIW)	71
GeA1	17	2aA(I)	45
GeB1	17	2aB(IIE)	46
GeB2	17	2aB(IIE)	46
GeC1	17	2aC(IIIE)	47
GeC2	17	2aC(IIIE)	47
GeC3	17	2aC(IVE)	48
GeD1	17	2aD(IVE)	48
GeD2	17	2aD(IVE)	48
GeD3	17	2aD(VIE)	49
GfA1	17	2aA(I)	45
GfA2	17	2aB(IIE)	46
GfB1	17	2aB(IIE)	46
GfB2	17	2aB(IIE)	46
GfB3	17	2aB(IIIE)	47
GfC1	17	2aC(IIIE)	47
GfC2	17	2aC(IIIE)	47
GfC3	17	2aC(IVE)	48
GfD1	18	2aD(IVE)	48
GfD2	18	2aD(IVE)	48
GfD3	18	2aD(VIE)	49
GfE1	18	2aE(VIE)	49
GfE2	18	2aE(VIE)	49

TABLE 7.—*Guide to mapping units and soil management units*—Continued

Map symbol	Mapping unit described on page—	Soil management unit	Managemen unit described on page—
GfE3	18	2aE(VIE)	49
HaA0	18	Mc(IIIW)	72
HbA0	19	Mc(IIIW)	72
HcB1	19	2aB(IIE)	46
IaA0	20	4bA(IIIW)	62
IaB1	20	4bB(IIIW)	63
IbA0	21	4bA(IIIW)	62
IbB1	21	4bB(IIIW)	63
IcA0	20	4bA(IIIW)	62
IcB1	20	4bB(IIIW)	63
IcC1	20	4aC(IIIS)	61
IcD1	20	4aD(IVS)	61
JaA0	21	2cA(IIW)	52
KaA1	21	5aA(IVS)	65
KaB1	21	5aB(IVS)	65
KaC1	21	5aD(VIIS)	66
KbA0	22	L3c(VW)	69
La	22	S(VIIIS)	72
Lb	22	S(VIIIS)	72
Lc	22	S(VIIIS)	72
LdA0	22	M/3c(IIW)	71
LeA0	23	M/3c(IIW)	71
LfA0	23	2bA(I)	49
LfB1	23	2bB(IIW)	50
LfB2	23	2bB(IIW)	50
LgA0	23	2bA(I)	49
LgB1	23	2bB(IIW)	50
LgB2	23	2bB(IIW)	50
LgC1	23	2bB(IIW)	50
MaA1	24	3aA(IIS)	53
MaB1	24	3aB(IIS)	54
MaB2	24	3aB(IIS)	54
MaC1	24	3aC(IIIS)	55
MaC2	24	3aC(IIIS)	55
MaD1	24	3aD(IVS)	55
MaD2	24	3aD(IVS)	55
MaD3	24	3aE(VIS)	56
MbA1	24	3aA(IIS)	53
MbB1	24	3aB(IIS)	54
MbB3	24	3aB(IIS)	54
MbC1	24	3aC(IIIS)	55
MbC2	24	3aC(IIIS)	55
MbD1	24	3aD(IVS)	55
MbE3	24	3aE(VIS)	56
McA0	25	3bA(IIW)	56
McB1	25	3bB(IIW)	57
Md	25	S(VIIIS)	72
MeA1	25	4aA(IIIS)	59
MeB1	25	4aB(IIIS)	60
MeB2	25	4aB(IIIS)	60
MeC1	25	4aC(IIIS)	61
MeC2	25	4aC(IIIS)	61
MeD1	25	4aE(VIIS)	62
MeD2	25	4aE(VIIS)	62
MeD3	25	4aE(VIIS)	62
MfA1	26	2aA(I)	45
MfB1	26	2aB(IIE)	46
MfB2	26	2aB(IIE)	46
MfB3	26	2aB(IIIE)	47
MfC1	26	2aC(IIIE)	47
MfC2	26	2aC(IIIE)	47
MfC3	26	2aC(IVE)	48
MfD1	26	2aD(IVE)	48
MfD2	26	2aD(IVE)	48
MfD3	26	2aD(VIE)	49
MfE2	26	2aE(VIE)	49
MgA1	26	2aA(I)	45
MgB1	26	2aB(IIE)	46
MgB2	26	2aB(IIE)	46
MgC1	26	2aC(IIIE)	47
MgC2	26	2aC(IIIE)	47

TABLE 7.—*Guide to mapping units and soil management units*—Continued

Map symbol	Mapping unit described on page—	Soil management unit	Management unit described on page—
MhA1	27	5aA(IVS)	65
MhB1	27	5aB(IVS)	65
MkC1	27	5aC(IVS)	66
MkD2	27	5aD(VIIS)	66
MmC1	27	4aC(IIIS)	61
MmC2	27	4aC(IIIS)	61
MnA1	28	4aA(IIIS)	59
MnB1	28	4aB(IIIS)	60
MnB2	28	4aB(IIIS)	60
MnC1	28	4aC(IIIS)	61
MnC2	28	4aC(IIIS)	61
MnD1	28	4aD(IVS)	61
MnD2	28	4aD(IVS)	61
NaA1	28	3aA(IIS)	53
NaB1	28	3aB(IIS)	54
NaC1	28	3aC(IIIS)	55
NaC2	28	3aC(IIIS)	55
OaA0	29	4bA(IIIW)	62
OaB1	29	4bB(IIIW)	63
PaA0	29	M/3c(IIW)	71
PbA0	29	M/3c(IIW)	71
PcA0	30	2cA(I)	52
PcB1	30	2cA(I)	52
PdA0	30	2cA(I)	52
PeA0	30	2cA(I)	52
PfA0	30	2bA(I)	49
RaA0	31	3bA(IIW)	56
RaB1	31	3bB(IIW)	57
RbA0	31	Mc(IIIW)	72
RcA0	32	5cA(IVW)	68
RdA0	32	5cA(IVW)	68
ReA1	32	5.3aA(VIIS)	68
ReB1	32	5.3aA(VIIS)	68
ReB3	32	5.3aC(VIIS)	68
ReC1	32	5.3aC(VIIS)	68
ReC2	32	5.3aC(VIIS)	68
ReD1	32	5.3aC(VIIS)	68
ReD3	32	5.3aC(VIIS)	68
SaA0	33	3bA(IIW)	56
SaB1	33	3bB(IIW)	57
SbA0	33	3bA(IIW)	56
SbB1	33	3bB(IIW)	57
SbB2	33	3bB(IIW)	57
SbC1	33	3bC(IIIW)	57
SbC2	33	3bC(IIIW)	57
SbD1	33	3bD(IVE)	57
SbD2	33	3bD(IVE)	57
ScA0	34	Mc-a(VIIIW)	71
TaA0	34	2cA(I)	52
TbA0	34	2cA(I)	52
TcA0	34	M/4c(IVW)	71
TdA0	34	2cA(I)	52
TeA0	35	5cA(IVW)	68
TfA0	35	3cA(IIW)	58
TgA0	35	3cA(IIW)	58
TgB1	35	3cA(IIW)	58
ThA0	36	4/Rb(IVW)	63
ThB1	36	4/Rb(IVW)	63
ThC1	36	4/Rb(IVW)	63
WaA0	36	L2c(IIIW)	69
WbA0	36	M/mc(IVW)	71
WcA0	36	L2c(IIIW)	69
WcB0	36	L2c(IIIW)	69
WdA0	37	L2c(IIIW)	69
WdB0	37	L2c(IIIW)	69
WeA0	37	M/1c(IIIW)	71

In table 7, the capability class and subclass designation of the Soil Conservation Service is shown in parentheses. The capability unit designation used in Sanilac County by the Soil Conservation Service consists of the complete symbols in the table; for example, 2aB(IIE).

Management by Groups and Units

In this subsection, a discussion of the management group precedes the discussions of the soil management units that make up the group. In the discussion of a group are general descriptions of the soils that make up the group, suggested crop rotations, and recommended ratios and grades of fertilizer as well as rates of application. Other suggestions that apply to the group as a whole are also included.

Suggested rotations and their value of relative protectiveness are given for all management groups of well-drained soils except group 5.3a. The protectiveness of a cropping system depends on how well the system controls erosion and maintains tilth and productivity. It varies with the completeness of its ground cover and the proportion of the year that crops cover the soil. Legume-grasses provide more complete cover than small grains, and small grains more than row crops. Rotations that require changing the crop are less protective than continuous forage or forest. This is because the soil is not covered while the new crop is being established. Erosion losses are decreased by planting a green-manure crop with a row crop, or by using a field cultivator when the soil is prepared for seeding legume-grass with a small grain. The values of relative protectiveness of 64 cropping systems are given in table 4.

In the descriptions of the management units, the soils that make up the units are listed and described generally. The uses of the soils in the unit, crop suitability, and suggested management are given. Estimated yields are listed for two levels of management—prevailing management and improved management.

Under prevailing management, some legume-grass is used in the crop rotation. Barnyard manure that is produced on the farms is returned to the soils. Lime is applied, although in many places in insufficient amounts. Some commercial fertilizer is applied. In most places, a fairly regular rotation is used, but row crops are grown much of the time. Poorly drained areas are artificially drained, in most places by tile. On the more rolling or sandy soils, the rotations include a larger proportion of a legume-grass than do those on the more nearly level, finer textured soils, where more row crops or small grains are grown.

Under improved management, the proper proportion of row crops to legume-grass crops is used. The quantity of lime used is determined by soil tests. Fertilization is also determined by soil tests and is based on the amounts and kinds of plant food needed by the crop. Where needed, an adequate system of artificial drainage is installed. Improved varieties of plants and high-quality seeds are used. Other conservation practices are used, where needed, to reduce erosion and to improve the moisture content. These practices are contour tillage, stripcropping, terracing, and the construction of diversion ditches.

The crop yields listed are averages that might be expected over a period of several years under the two broadly defined kinds of management. Because the

amount and distribution of rainfall and the length of the growing season vary, these yields cannot be expected every year. Nor can the yields be expected on every farm. Soils differ from place to place, and management differs from farm to farm. The yields are the best estimates of relative productivity that can now be made for the soils in the management units.

Soil management group 2a

Soil management group 2a consists mainly of light-colored, medium-textured, well-drained soils that formed from loam to silty clay loam parent materials.

The management units within this group have different slope ranges and different degrees of erosion. The slope ranges are designated by capital letters that follow the group symbol. In group 2a, the capital letters and the slopes they stand for are:

A______________ 0 to 2 percent slopes (nearly level).
B______________ 2 to 6 percent slopes (gently sloping).
C______________ 6 to 12 percent slopes (moderately sloping).
D______________ 12 to 18 percent slopes (strongly sloping).
E______________ 18+ percent slopes (steep).

In this management group, the soils that have the steeper and longer slopes need the more protective cropping system. The length of slope is the distance that water normally flows on the slope before it enters a drainageway. The more eroded soils also require a more protective cropping system.

Practices for controlling water erosion protect the soil and allow the farmer to grow more row crops and small grains. Without practices to control water erosion, a ROgm (57)[6] rotation is effective for the soils in management unit 2aA(I) but the more protective rotation ARW (81) is needed for the more sloping soils in management unit 2aB(IIE). Management unit 2aC(IIIE) has soils with slopes of 6 to 12 percent and needs an AAO(96) rotation unless practices are used to control water erosion. With contour tillage, unit 2aC(IIIE) needs an AAAARO (91) rotation; with stripcropping, an AARO (86) rotation; and with terracing, an ARWgmRW(72) rotation.

In table 8, crop rotations are recommended for each soil management unit in group 2a. These rotations are the least protective that can be recommended for safe use under the practices of erosion control named in table 8. The rotations listed in table 4 that have a value of relative protectiveness less than those in table 8 do not adequately protect the soil if it is cultivated under the practices named. Cropping systems that have a greater value should adequately protect the soil. Minimum tillage, the removal of crop residues, and other practices may affect the amount of protection required. The protection needed decreases with a decrease in slope and as other erosion control practices are used.

The rotations recommended in table 8 are based on a slope 200 feet long. Except where terraces are used, a more protective rotation than that given is needed on a slope longer than 200 feet. A slightly less protective rotation can be used on a slope shorter than 200 feet.

The soils in management group 2a have a low natural supply of organic matter. Unless properly managed, these soils tend to be crusted on the surface or compacted. Thus, conditions unfavorable for the growth of roots and the absorption of water are created. Organic matter can be supplied (1) by crop rotations that provide deep-rooted crops, (2) by crop residues left on the field, and (3) by additions of manure.

Fertilizer ratios, grades, and rates of application should be selected according to the crop to be grown, the kind of soil, and the results of soil tests. In table 9, for named crops, are suggested ratios, grades, and rates for application of fertilizer to the soils in groups 2a and 2b, when the soil tests are as indicated in the table.

SOIL MANAGEMENT UNIT 2aA(I)

Nearly level, slightly eroded, light-colored, medium-textured, well-drained soils

GeA1 Guelph loam, 0 to 2 percent slopes, slightly eroded.
GfA1 Guelph loam and silt loam, 0 to 2 percent slopes, slightly eroded.

[6] The meaning of the symbols for rotations and relative protectiveness are given in table 4.

TABLE 8.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water-erosion control, for the soil management units in group 2a*

Soil management unit	Slope	Erosion	Practices of water-erosion control			
			None	Contour tillage	Stripcropping	Terracing
	Percent					
2aA(I)	0–2	Slight	ROgm [1](57)[2]	Not used	Not used	Not used.
2aB(IIE)	2–6	Slight and moderate	ARW(81)	AARRO(77)	AAARRO(80)	ROgm(57).
2aB(IIIE)	2–6	Severe	AAAARO(91)	AAARRO(80)	AARO(86)	ARROW(69).
2aC(IIIE)	6–12	Slight and moderate	AAO(96)	AAAARO(91)	AARO(86)	ARWgmRW(72).
2aC(IVE)	6–12	Severe	AAO(96)	AAAARO(91)	AARO(86)	AARRO(77).
2aD(IVE)	12–18	Slight and moderate	AAW(97)	AAW(97)	AAAARO(91)	Not recommended.
2aD(VIE)	12–18	Severe	AAW(97)	AAW(97)	AAAARO(91)	Not recommended.
2aE(VIE)	18+	Slight, moderate, and severe	Permanent vegetation (grass or trees).			

[1] Rotation symbols: A, legume-grass; gm, green manure; O, spring grains; R, row crops; W, winter grains. These symbols are the same as those in table 4. Rotations are recommended on the assumption that all crop residues, at least 2 tons per acre, are returned to the soil and plowed under immediately before planting.

[2] Number in parentheses refers to the relative protectiveness of the cropping system (see table 4). A cropping system that has a value of relative protectiveness greater than the one given also can be used for a particular soil management unit and erosion control practice.

TABLE 9.—*Recommended fertilization for*

[N stands for nitrogen, P_2O_5 for phos

Crops	If the soil tests— Low in phosphorus and low in potassium— Apply per acre— N	P₂O₅	K₂O	At rate and grade of [1]—	Low in phosphorus and high in potassium— Apply per acre— N	P₂O₅	K₂O
	Lb.	Lb.	Lb.		Lb.	Lb.	Lb.
Alfalfa,[2] alfalfa-bromegrass,[2] clover, and sweetclover	0	80	40	400 lb. of 0-20-10	0	80	20
Alfalfa after each harvest year [2]	0	60	60	300 lb. of 0-20-20	0	60	30
Grass without a legume	50	25	25	312 lb. of 16-8-8	50	25	0
Barley [3] or oats [3] with legume seeding	20	80	40	400 lb. of 5-20-10	20	80	20
Barley [3 4] or oats [3 4] without legume seeding	30	60	30	300 lb. of 10-20-10	30	60	30
Field beans [3 4]	12	50	25	250 lb. of 5-20-10	12	50	12
Soybeans [3 4]	10	40	20	200 lb. of 5-20-10	10	40	10
Sugar beets [3 4 5]	30	120	60	600 lb. of 5-20-10	30	120	30
Wheat [3] or rye [3] with legume seeding	22	90	45	450 lb. of 5-20-10	22	90	22
Wheat [3 4] or rye [4] without legume seeding	20	80	40	400 lb. of 5-20-10	20	80	20
Corn [4 6]	15	60	30	300 lb. of 5-20-10	15	60	15

[1] Rates and grades are examples of recommended fertilization. Other rates and grades can be used to obtain the suggested amounts of nitrogen, phosphoric acid, and potash.

[2] Apply fertilizer containing ½ percent boron if pH is above 6.5.

[3] Apply fertilizer containing 1 to 2 percent manganese if pH is above 6.9.

MfA1 Marlette loam, 0 to 2 percent slopes, slightly eroded.
MgA1 Marlette silt loam and loam, 0 to 2 percent slopes slightly eroded.

These well-drained soils are generally fertile and have a high capacity for holding moisture. They are not susceptible to water eroson or wind erosion.

These soils are well suited to row crops, small grains, legume-grasses, and trees. Trees generally are not planted on these soils, but yields of forest products are high if woodlots are properly stocked and adequately managed.

Rotations that provide a row crop half of the time and a small grain seeded to a green-manure crop the other half (57) are satisfactory if the crop residues are returned to the soil (see table 8). Other rotations are given in table 4. Any rotation in this table with a value of relative protectiveness greater than (57) also can be used safely on this soil management unit. When row crops, small grains, or legume-grasses are grown, fertilizers should be applied at the rate indicated by soil tests (see table 9). High yields of most crops are obtained if adequate fertilizer is used.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		Prevailing management	Improved managemen
Corn	bushels	40	80
Beans	bushels	14	25
Sugar beets	tons	8	14
Wheat	bushels	24	42
Oats	bushels	36	76
Barley	bushels	28	51
Alfalfa	tons	2.3	3.4
Mixed hay	tons	1.6	2.4

SOIL MANAGEMENT UNIT 2aB(IIE)

Nearly level to gently sloping, slightly to moderately eroded, light-colored, medium-textured, well-drained soils

GeB1 Guelph loam, 2 to 6 percent slopes, slightly eroded.
GeB2 Guelph loam, 2 to 6 percent slopes, moderately eroded.
GfA2 Guelph loam and silt loam, 0 to 2 percent slopes, moderately eroded.
GfB1 Guelph loam and silt loam, 2 to 6 percent slopes, slightly eroded.
GfB2 Guelph loam and silt loam, 2 to 6 percent slopes, moderately eroded.
HcB1 Huron silt loam, 2 to 6 percent slopes, slightly eroded.
MfB1 Marlette loam, 2 to 6 percent slopes, slightly eroded.
MfB2 Marlette loam, 2 to 6 percent slopes, moderately eroded.
MgB1 Marlette silt loam and loam, 2 to 6 percent slopes, slightly eroded.
MgB2 Marlette silt loam and loam, 2 to 6 percent slopes, moderately eroded.

These soils are well suited to row crops, small grains, legume-grasses, and trees. Under good management, excellent yields of all crops can be grown. White pine, red pine, Scotch pine, Austrian pine, and Norway spruce grow well on these soils, but they are seldom planted. If properly managed, woodlots produce high yields.

Water erosion has occurred in many places. If erosion control practices are not used, a suitable crop rotation consists of 1 year of legume-grass, 1 year of a row crop, and 1 year of a small grain (81) (see table 8). If stripcropping is used, an adequate rotation will keep legume-grass on the land half of the time (80). With terraces, a suitable rotation is 1 year of a row crop and 1 year of a small grain seeded to a green-manure crop (57). If contour tillage alone is used, a suitable rotation is 2 years of a legume-grass, 2 years of a row crop, and spring grain seeded to legume-grass (77). Other rotations are given

soil management groups 2a and 2b

phoric acid, and K_2O for potash]

If the soil tests—Continued								
Low in phosphorus and high in potassium—Continued	High in phosphorus and low in potassium—				High in phosphorus and high in potassium—			
At rate and grade of [1]—	Apply per acre— N	Apply per acre— P_2O_5	Apply per acre— K_2O	At rate and grade of [1]—	Apply per acre— N	Apply per acre— P_2O_5	Apply per acre— K_2O	At rate and grade of [1]—
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	
200 lb. of 0-20-0 plus 200 lb. of 0-20-10.	0	40	40	200 lb. of 0-20-20	0	40	20	200 lb. of 0-20-10.
300 lb. of 0-20-10	0	30	60	200 lb. of 0-15-30	0	30	30	150 lb. of 0-20-20.
150 lb. of 33-0-0 plus 125 lb. of 0-20-0.	50	0	25	150 lb. of 33-0-0 plus 40 lb. of 0-0-60.	50	0	0	150 lb. of 33-0-0.
400 lb. of 5-20-5	20	40	40	250 lb. of 8-16-16	20	40	20	200 lb. of 10-20-10.
300 lb. of 10-20-10	30	30	30	300 lb. of 10-10-10	30	30	30	300 lb. of 10-10-10.
250 lb. of 5-20-5	12	25	25	150 lb. of 8-16-16	12	25	12	125 lb. of 10-20-10.
200 lb. of 5-20-5	10	20	20	125 lb. of 8-16-16	5	20	10	100 lb. of 5-20-10.
600 lb. of 5-20-5	30	60	60	375 lb. of 8-16-16	30	60	30	300 lb. of 10-20-10.
450 lb. of 5-20-5	22	45	45	280 lb. of 8-16-16	22	45	22	200 lb. of 10-20-10.
400 lb. of 5-20-5	20	40	40	250 lb. of 8-16-16	20	40	20	200 lb. of 10-20-10.
300 lb. of 5-20-5	15	30	30	190 lb. of 8-16-16	15	30	15	150 lb. of 10-20-10.

4 Supplemental nitrogen may be needed.
5 Apply fertilizer containing ¼ percent boron if pH is above 6.5.
6 If corn is planted year after year, apply yearly to soils low in fertility 100 pounds of nitrogen, 50 pounds of phosphoric acid, and 50 pounds of potash per acre.

in table 4. Any rotation with a greater value of relative protectiveness than the one given for a particular practice in table 8 also can be used. All crop residues should be returned to the soil. Waterways can be protected from erosion by seeding a mixture of grasses and legumes and keeping the waterways in sod.

In some wet, seepy places, tile is needed to intercept seepage along slopes. The tile should be placed on the higher side of the seepage areas at depths of 3 to 4 feet or where an impermeable layer occurs.

After the soil is tested, apply lime in amounts shown in table 5 and apply fertilizer at the rates given in table 9.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	40	80
Beans	bushels	14	25
Sugar beets	tons	8	14
Wheat	bushels	24	42
Oats	bushels	36	76
Barley	bushels	28	51
Alfalfa	tons	2.3	3.4
Mixed hay	tons	1.6	2.4

SOIL MANAGEMENT UNIT 2aB(IIIE)

Gently sloping, severely eroded, light-colored, medium-textured, well-drained soils

GfB3 Guelph loam and silt loam, 2 to 6 percent slopes, severely eroded.
MfB3 Marlette loam, 2 to 6 percent slopes, severely eroded.

These soils are naturally fertile and have a high water-holding capacity. The main problems are control of further water erosion and application of practices to offset the results of past erosion.

Past erosion and the hazard of further erosion narrow crop suitability. If adequately fertilized, these soils are well suited to legume-grasses. They are not well suited to sugar beets and field beans, as yields will be low. White pine, Austrian pine, and ponderosa pine are suitable trees, but generally they are not planted.

Table 8 gives satisfactory rotations for these soils under several practices of erosion control.

Keep all waterways in sod, and seed cover crops with row crops. Return all residues to the soil. Small, wet, seepy areas need to be drained by a random system of tile.

After the soils are tested, apply lime in amounts shown in table 5 and apply fertilizer at the rates and grades given in table 9 for named crops.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	35	65
Beans	bushels	12	20
Sugar beets	tons	6	10
Wheat	bushels	18	35
Oats	bushels	30	60
Barley	bushels	22	42
Alfalfa	tons	2.0	3.2
Mixed hay	tons	1.5	2.2

SOIL MANAGEMENT UNIT 2aC(IIIE)

Moderately sloping, slightly to moderately eroded, light-colored, medium-textured, well to moderately well drained soils

GaC1 Gagetown silt loam, 6 to 12 percent slopes, slightly eroded.

GaC2 Gagetown silt loam, 6 to 12 percent slopes, moderately eroded.
GeC1 Guelph loam, 6 to 12 percent slopes, slightly eroded.
GEC2 Guelph loam, 6 to 12 percent slopes, moderately eroded.
GfC1 Guelph loam and silt loam, 6 to 12 percent slopes, slightly eroded.
GfC2 Guelph loam and silt loam, 6 to 12 percent slopes, moderately eroded.
MfC1 Marlette loam, 6 to 12 percent slopes, slightly eroded.
MfC2 Marlette loam, 6 to 12 percent slopes, moderately eroded.
MgC1 Marlette silt loam and loam, 6 to 12 percent slopes, slightly eroded.
MgC2 Marlette silt loam and loam, 6 to 12 percent slopes, moderately eroded.

Under adequate management, these soils are suited to crops and trees. Sugar beets and field beans are not so well suited, because of the erosion hazard. If adequately fertilized and limed, all the legume-grasses of the area can be grown. Trees generally are not planted, but white pine, Norway spruce, and red pine grow well on these soils and produce good yields.

In most areas a legume-grass in the rotation reduces water erosion. If practices of erosion control are not used, 1 year of a small grain and 2 years of a legume-grass can be grown (96) (see table 8). Row crops, however, are not recommended. If contour tillage is used, a suggested rotation consists of 4 years of a legume-grass, 1 year of a row crop, and 1 year of a small grain seeded to a legume-grass (91). With terraces, a satisfactory 5-year rotation provides a legume-grass, a row crop, a winter grain seeded to a green-manure crop, and a row crop followed by a winter grain seeded to a legume-grass (72).

Return all crop residues to the soil, and apply lime and fertilizer as indicated by soil tests (see tables 5 and 9). Keep all waterways in sod. Tile is needed in some wet places to intercept seepage along slopes. Interceptor tile should be placed at depths of 3 to 4 feet or at the top of an impermeable layer. The tile should be placed on the higher side of seepage areas.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	30	70
Beans	bushels	10	20
Wheat	bushels	20	38
Oats	bushels	30	69
Barley	bushels	23	46
Alfalfa	tons	1.7	3.2
Mixed hay	tons	1.3	2.2

SOIL MANAGEMENT UNIT 2aC(IVE)

Moderately sloping, severely eroded, light-colored, medium-textured, well-drained soils

GeC3 Guelph loam, 6 to 12 percent slopes, severely eroded.
GfC3 Guelph loam and silt loam, 6 to 12 percent slopes, severely eroded.
MfC3 Marlette loam, 6 to 12 percent slopes, severely eroded.

These severely eroded soils are naturally fertile and have good moisture-holding capacity. They are slightly acid to calcareous. Because they are severely eroded, they are low in organic matter and generally have poor structure in the surface layer. Control of water erosion is the main problem of management.

These soils are suited to all crops commonly grown in the county except sugar beets and field beans. Legume-grasses produce good yields if they are properly limed and fertilized. Well-stocked woodlands provide high yields under good management. Although trees are seldom planted, white pine, Austrian pine, Norway spruce, and ponderosa pine are suitable for planting. Because of the reaction of the soils, red pine is not suitable.

Crop rotations that reduce water erosion are given in table 8. Rotations with a greater relative protectiveness can be used instead of the ones given for this management unit in table 8. Other suggested rotations that protect the soil are listed in table 4.

Keep all waterways in sod, and seed cover crops in the row crops. The more severely eroded areas need special treatment that will build up the soil and reduce further water erosion. Apply lime and fertilizer as indicated by soil tests and with consideration of the needs of the crop planted (see tables 5 and 9).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	25	55
Wheat	bushels	17	30
Oats	bushels	25	60
Barley	bushels	20	40
Alfalfa	tons	1.7	3.0
Mixed hay	tons	1.3	2.0

SOIL MANAGEMENT UNIT 2aD(IVE)

Strongly sloping, slightly to moderately eroded, light-colored, medium-textured, well to moderately well drained soils

GaD2 Gagetown silt loam, 12 to 18 percent slopes, moderately eroded.
GeD1 Guelph loam, 12 to 18 percent slopes, slightly eroded.
GeD2 Guelph loam, 12 to 18 percent slopes, moderately eroded.
GfD1 Guelph loam and silt loam, 12 to 18 percent slopes, slightly eroded.
GfD2 Guelph loam and silt loam, 12 to 18 percent slopes, moderately eroded.
MfD1 Marlette loam, 12 to 18 percent slopes, slightly eroded.
MfD2 Marlette loam, 12 to 18 percent slopes, moderately eroded.

These soils are naturally fertile and have a high moisture-holding capacity. Control of water erosion is the main management problem.

These soils are best suited to pasture. They are well suited to all the grasses and legumes grown in the county. Trees do fairly well. For new plantings, use white, Austrian, ponderosa, or Scotch pine.

If row crops are grown, they should be stripcropped in a rotation that has only 1 row crop in 6 years. This rotation should provide at least 4 years of a legume-grass and 1 year of spring grain seeded to legume-grass (91). These soils are too steep to be terraced effectively. Use contour tillage and keep the soil in grasses and legumes as much of the time as possible. Other rotations are given in table 4. Any rotation in table 4 that has a greater value of protectiveness than the one given in table 8 for the various practices can be used.

Keep the natural drainageways in grass. After the soil is tested, apply lime in amounts indicated in table 5, and fertilizer at the rates and grades given in table 9 for the named crops.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ... bushels	30	70
Wheat ... bushels	20	38
Oats ... bushels	30	69
Barley ... bushels	23	46
Alfalfa ... tons	1. 7	3. 0
Mixed hay ... tons	1. 3	2. 0

SOIL MANAGEMENT UNIT 2aD(VIE)

Strongly sloping, severely eroded, light-colored, medium-textured, well-drained soils

GeD3 Guelph loam, 12 to 18 percent slopes, severely eroded.
GfD3 Guelph loam and silt loam, 12 to 18 percent slopes, severely eroded.
MfD3 Marlette loam, 12 to 18 percent slopes, severely eroded.

These soils have many severely eroded areas. The clay loam subsoil is exposed in eroded fields. Water erosion is the main management problem.

These soils are best suited to pasture. They are well suited to the grasses and legumes grown in the county. Trees grow fairly well. For new plantings, use white, Austrian, ponderosa, or Scotch pine.

If row crops are grown, plant them in strips and use a rotation that has only 1 row crop in 6 years. This rotation should also provide 4 years of a legume-grass and 1 year of a small grain seeded to a legume-grass (91) (see table 8). Any rotation that provides greater relative protectiveness can be used (see table 4).

These soils are too steep to be terraced effectively. Use contour tillage, and keep the soil in grasses and legumes as much of the time as possible. Keep all waterways in sod. After the soil is tested, apply lime in the amounts suggested in table 5 and apply fertilizer at the rates and grades suggested in table 9 for the named crops.

SOIL MANAGEMENT UNIT 2aE(VIE)

Steep, slightly to severely eroded, light-colored, medium-textured, well-drained soils

GfE1 Guelph loam and silt loam, 18+ percent slopes, slightly eroded.
GfE2 Guelph loam and silt loam, 18+ percent slopes, moderately eroded.
GfE3 Guelph loam and silt loam, 18+ percent slopes, severely eroded.
MfE2 Marlette loam, 18 to 25 percent slopes, moderately eroded.

These soils are sheet eroded and gullied where they have been cropped. Water erosion is the main hazard. Some areas are severely eroded.

These soils can be best used for pasture and trees. Intertilled crops are not recommended. Adapted legumes and grasses used for pasture produce moderately high to high yields. Established stands of trees provide good yields of wood products. For new plantings, use white pine, Austrian pine, ponderosa pine, or white spruce.

When a new pasture is to be established, break the ground, fertilize, and seed legumes and grasses with a small-grain nurse crop. After the soils are tested, apply lime in the amounts suggested in table 5 and apply fertilizer at the rates and grades suggested for named crops in table 9.

Soil management group 2b

This soil management group consists mainly of moderately dark colored, medium-textured soils that formed from loam to silty clay loam parent materials under imperfect drainage.

The soils in this group are placed in soil management units according to percentage of slope. The slope range of a unit is designated by capital letters that follow the group symbol. In group 2b the capital letters and the slope ranges are:

A ... 0 to 2 percent slopes (nearly level).
B ... 2 to 6 or 6 to 12 percent slopes (gently to moderately sloping).

The soils in group 2b are naturally fertile and are seldom affected by water or wind erosion. They have a high moisture-holding capacity. The main management needs are adequate drainage and maintenance of soil structure and fertility.

Select fertilizer ratios, grades, and rates of application according to the crops to be grown, the kinds of soil, and the results of soil tests. In table 9 rates and grades of fertilization are given for named crops.

SOIL MANAGEMENT UNIT 2bA(I)

Nearly level, moderately dark colored, medium-textured soils formed under imperfect drainage

CaA0 Capac loam and fine sandy loam, 0 to 2 percent slopes.
CbA0 Capac silt loam and loam, 0 to 2 percent slopes.
LfA0 London loam and fine sandy loam, 0 to 2 percent slopes.
LgA0 London loam and silt loam, 0 to 2 percent slopes.
PfA0 Perth silt loam, 0 to 2 percent slopes.

If adequately drained, these soils are well suited to tilled crops, legume-grasses, and trees. Suitable crops are corn, sugar beets, dry beans, wheat, and oats. Most of the legumes and grasses grow well in adequately drained areas. Yields of forest products are medium to low on the more poorly drained sites.

A suitable rotation consists of a row crop followed by a small grain seeded to a green-manure crop (57). A suitable 3-year rotation for adequately drained areas is one that provides a row crop, a small grain, and a legume-grass (78). A suitable 4-year rotation provides 2 years of a legume-grass, a row crop, and a small grain (86). Other rotations are given in table 4. Any rotation with a value of relative protectiveness greater than (57) also can be used.

Return all crop residues to the soil and apply lime and fertilizer as indicated by soils tests for named crops (see tables 5 and 9).

Most of these soils require artificial drainage. Tile drains are generally effective because the soils are medium textured and have good structure in the subsoil. The tile should be placed at depths of 36 to 48 inches in lines that are 4 to 6 rods apart. Some wet spots can be drained by random tile.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ... bushels	50	90
Sugar beets ... tons	11	16
Beans ... bushels	17	28
Wheat ... bushels	28	46
Oats ... bushels	42	83
Barley ... bushels	32	55
Alfalfa ... tons	2. 5	3. 7
Mixed hay ... tons	2. 0	2. 7

TABLE 10.—*Recommended fertilization for*

[N stands for nitrogen, P_2O_5 for

Crops	If the soil test— Low in phosphorus and low in potassium— Apply per acre— N			At rate and grade of [1]—	Low in phosphorus and high in potassium— Apply per acre— N		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*
Alfalfa [2], alfalfa-brome [2], clover, and sweetclover	0	80	40	400 lb. of 0-20-10	0	80	20
Alfalfa, after each harvest year [2]	0	60	30	300 lb. of 0-20-10	0	60	0
Grass without a legume	50	25	25	312 lb. of 16-8-8	50	25	0
Barley [3] or oats [3] with legume seeding	20	80	40	400 lb. of 5-20-10	20	80	20
Barley [3 4] or oats [3 4] without legume seeding	30	60	30	300 lb. of 10-20-10	30	60	0
Field beans [3 4]	15	60	30	300 lb. of 5-20-10	15	60	15
Soybeans [3 4]	12	50	25	250 lb. of 5-20-10	12	50	12
Sugar beets [3 4 5]	40	160	80	800 lb. of 5-20-10	40	160	40
Wheat [3] or rye [3] with legume seeding	25	100	50	500 lb. of 5-20-10	25	100	25
Wheat [3 4] or rye [4] without legume seeding	20	80	40	400 lb. of 5-20-10	20	80	20
Corn [4 6]	20	80	40	400 lb. of 5-20-10	20	80	20

[1] Rates and grades are examples of recommended fertilization. Other rates and grades can be used to obtain the suggested amounts of nitrogen, phosphoric acid, and potash.

[2] Apply fertilizer containing ½ percent boron if pH is above 6.5.

[3] Where pH is above 6.5, apply fertilizer containing 1 or 2 percent manganese.

SOIL MANAGEMENT UNIT 2bB(IIW)

Gently to moderately sloping, slightly to moderately eroded, moderately dark colored, medium-textured soils formed under imperfect drainage

CaB1 Capac loam and fine sandy loam, 2 to 6 percent slopes, slightly eroded.
CbB1 Capac silt loam and loam, 2 to 6 percent slopes, slightly eroded.
CaC2 Capac loam and fine sandy loam, 6 to 12 percent slopes, moderately eroded.
CbB2 Capac silt loam and loam, 2 to 6 percent slopes, moderately eroded.
LfB1 London loam and fine sandy loam, 2 to 6 percent slopes, slightly eroded.
LfB2 London loam and fine sandy loam, 2 to 6 percent slopes, moderately eroded.
LgB1 London loam and silt loam, 2 to 6 percent slopes, slightly eroded.
LgB2 London loam and silt loam, 2 to 6 percent slopes, moderately eroded.
LgC1 London loam and silt loam, 6 to 12 percent slopes, slightly or moderately eroded.

These soils are well suited to most crops generally grown in the county. Yields are moderately high to high. Sugar beets and field beans, however, are not so well suited on the more sloping areas, which are difficult to manage. Most of the legumes and grasses grown in the county do well if these soils are adequately drained. Trees generally are not planted. Yields from woodlands on the more poorly drained areas are low.

A suitable rotation consists of a row crop followed by a small grain seeded to a green-manure crop (57). A 3-year rotation that provides a row crop, a small grain, and legume-grass is satisfactory on these soils where they are adequately drained (81). Other rotations are given in table 4. Any rotation with a value of relative protectiveness greater than (57) also can be used. A suitable rotation helps to maintain soil structure and to reduce water erosion.

Return all crop residues to the soil and apply lime and fertilizer as indicated by soil tests (see tables 5 and 9). Keep tillage to a minimum to help maintain good soil structure. Keep drainageways in sod.

For maximum production, these soils should be artificially drained and have runoff controlled. Title should be laid with extreme care so that grades are avoided that would make the tile lines difficult to maintain. Random tile can be used to drain some isolated wet spots.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	50	90
Sugar beets	tons	11	16
Beans	bushels	17	28
Wheat	bushels	28	46
Oats	bushels	42	83
Barley	bushels	32	55
Alfalfa	tons	2.5	3.7
Mixed hay	tons	2.0	2.7

Soil management group 2c

This soil management group consists of nearly level to gently sloping, dark-colored, moderately fine to medium textured soils that formed from loam to silty clay loam parent materials under poor drainage conditions.

The soils in this management group are the most productive in the county for field crops if the soils are ade-

soil management groups 2c and L2c

phosphoric acid, and K_2O for potash]

If the soil test—Continued								
Low in phosphorus and high in potassium—Continued	High in phosphorus and low in potassium—				High in phosphorus and high in potassium—			
At rate and grade of [1]—	Apply per acre—			At rate and grade of [1]—	Apply per acre—			At rate and grade of [1]—
	N	P_2O_5	K_2O		N	P_2O_5	K_2O	
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	
400 lb. of 0-20-0 or 400 lb. of 5-20-5.	0	40	40	200 lb. of 0-20-20	0	40	20	200 lb. of 0-20-10.
300 lb. of 0-20-0	0	30	30	150 lb. of 0-20-20	0	30	15	150 lb. of 0-20-10.
150 lb. of 33-0-0 plus 125 lb. of 0-20-0.	50	0	25	150 lb. of 33-0-0 plus 40 lb. of 0-0-60.	50	0	0	150 lb. of 33-0-0.
400 lb. of 5-20-5	20	40	40	250 lb. of 8-16-16	20	40	20	200 lb. of 10-20-10.
90 lb. of 33-0-0 plus 300 lb. of 0-20-0.	30	30	30	300 lb. of 10-10-10	30	30	15	300 lb. of 10-10-10.
300 lb. of 5-20-5	15	30	30	190 lb. of 8-16-16	15	30	15	150 lb. of 10-20-10.
250 lb. of 5-20-5	12	25	25	150 lb. of 8-16-16	12	25	12	125 lb. of 10-20-10.
800 lb. of 5-20-5	40	80	80	500 lb. of 8-16-16	40	80	40	400 lb. of 10-20-10.
500 lb. of 5-20-5	25	50	50	310 lb. of 8-16-16	25	50	25	250 lb. of 10-20-10.
400 lb. of 5-20-5	20	40	40	250 lb. of 8-16-16	20	40	20	200 lb. of 10-20-10.
400 lb. of 5-20-5	20	40	40	250 lb. of 8-16-16	20	40	20	200 lb. of 10-20-10.

[4] Supplemental nitrogen may be needed.

[5] Apply fertilizer containing ¼ percent boron if pH is above 6.5.

[6] If corn is planted year after year, apply yearly to soils low in fertility 120 pounds of nitrogen, 60 pounds of phosphoric acid, and 60 pounds of potash per acre.

quately drained and their soil structure and fertility are maintained. In some areas satisfactory outlets for field drains are lacking, and, in these places, the soils are generally seeded and fertilized and used for permanent pasture. Reed canarygrass is grown in some of the wetter areas.

The soils in management group 2c seldom require applications of lime. They are neutral to calcareous and are generally deficient in manganese and boron. These minor elements may be needed for certain crops (see table 10). Where soil tests indicate that the soils in this group are acid, the liming rates suggested in table 5 should be increased by half. This is because the surface layer of the soils in group 2c contain a large amount of organic matter. Fertilizer ratios, grades, and rates of application should be selected according to the crops to be grown, the kinds of soil, and the results of soil tests. Table 10 lists rates of fertilization for named crops.

Although the soils in management group 2c are relatively high in organic matter, their good granular structure will be destroyed if the cropping system is too intense or if the content of organic matter is not maintained. Poor soil structure may hinder the movement of air and water through the soil to the extent that water will move slowly into the tile drains. Because these soils have a high content of silt and clay, care is needed to prevent the surface from packing or puddling, so that a crust will not form on the surface. This crust is difficult for plants to penetrate. Do not plow these soils until the moisture content is low enough for the soil to crumble as the furrow turns.

Increased yields on soils that are drained justify the expense of installing drainage systems. These soils contain enough silt and clay to stabilize the tile line trenches, and yet are porous enough to permit excess water to drain to the lines. The tile should be placed at depths of 3 to 4 feet, and the lines spaced not more than 4 rods apart. The laterals in the system need 5-inch tile. After the tile is in place, the effectiveness of the system will be improved if the tile is covered with straw, grass, or material in the plow layer. If adequate outlets are not available, underground silos can be used as outlets for tile drains. The water drains into the silos and is then pumped into higher ditches by sump pumps.

The soils of management group 2c may be used to grow corn year after year if the management practices include (1) adequate drainage, (2) minimum tillage, (3) use of certified seed of adapted varieties, (4) use of seed treated with fungicides and insecticides, (5) application of fertilizers as indicated by soil tests, (6) proper placement of fertilizers, (7) application of sufficient nitrogen fertilizer, (8) control of weeds, (9) seeding of green-manure crops, (10) return of crop residues to the soil, and (11) proper timing of all cultural operations.

A slight deviation from the optimum in any one of the above management practices would not greatly reduce the yields of corn grown year after year. But deviation in several of the practices mentioned, or complete disregard of any one practice, would decidedly reduce corn yields. Continuous corn should be restricted to soil management groups 2c and 3c and then used only when all the recommended cultural practices are followed.

SOIL MANAGEMENT UNIT 2cA(I)

Nearly level to gently sloping, dark-colored, medium-textured soils developed under poor drainage

PcA0 Parkhill loam, 0 to 2 percent slopes.
PcB1 Parkhill loam, 2 to 6 percent slopes, slightly eroded.
PdA0 Parkhill loam and clay loam, 0 to 2 percent slopes.
PeA0 Parkhill loam and mucky loam, 0 to 2 percent slopes.
TaA0 Tappan loam, 0 to 2 percent slopes.
TbA0 Tappan mucky loam, 0 to 2 percent slopes.
TdA0 Thomas mucky silt loam, 0 to 2 percent slopes.

If the soils in this management unit are adequately drained and well managed, yields are high. These soils are well suited to field crops, pasture, and trees. Because of wetness, however, few areas are planted to trees. The yields from woodlands are generally low. Yields of forage crops are high in areas that have been adequately drained. These soils are suited to most legumes and grasses grown in the county. When supplemental drainage is not installed, the selection of legumes and grasses will depend on the degree of wetness of the soil.

These soils need to be artificially drained if crops are grown in rotation. Tile placed at depths of 36 to 48 inches is satisfactory if the lines are spaced 4 rods apart.

A suitable rotation consists of a row crop followed by a small grain that is seeded to a green-manure crop (57). Another suitable rotation consists of 1 year of alfalfa, 1 year of a row crop, and 1 year of a small grain seeded to alfalfa (81). For both of these rotations, all crop residues should be returned to the soil, minimum tillage used, and fertilizers applied in amounts suggested in table 10. Other suggested rotations are listed in table 4. Any rotation that has a value of relative protectiveness greater than (57) also can be used.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	55	95
Beans	bushels	20	30
Sugar beets	tons	13	18
Wheat	bushels	30	50
Oats	bushels	45	90
Barley	bushels	35	60
Alfalfa	tons	2.7	4.0
Mixed hay	tons	2.2	3.0

SOIL MANAGEMENT UNIT 2cA(IIW)

Nearly level, dark-colored, moderately fine textured soil developed under poor drainage

JoA0 Jeddo silty clay loam, 0 to 2 percent slopes.

This soil has a high percentage of very fine silts and is, therefore, slowly permeable. The structure is difficult to maintain. The soil has, however, a high capacity for holding moisture and good natural fertility.

This soil is well suited to all field crops commonly grown in the county. Yields are slightly lower than on the soils in management unit 2cA(I). Yields of forage crops are high where drainage is adequate. Most legumes and grasses grown in the county are suitable. Where this soil is not artificially drained, the selection of forage crops depends on the wetness of the soil. Because of wetness, few areas are planted to trees. Yields from the woodland are generally low.

This soil needs artificial drainage if field crops are grown. Tile placed at depths of 36 to 48 inches is satisfactory if the lines are spaced 3 to 4 rods apart. To keep tile functioning properly, the rotations must include crops that return to the soil a large amount of organic matter in the form of crop residues.

A suggested rotation consists of 1 year of alfalfa, 1 year of a row crop, and 1 year of a small grain seeded to alfalfa (78). Other crop rotations are listed in table 4. Any rotation that has a value of relative protectiveness greater than (78) can be used.

Use minimum tillage to help maintain soil structure. Apply fertilizer in amounts and grades indicated by soil tests for named crops (see table 10).

Soil management group 3a

This soil management group consists of well to moderately well drained, light-colored soils that developed from sandy loam parent materials. Some of these soils have a weakly to strongly developed fragipan, and others have 18 to 42 inches of loamy fine sand to sandy loam over loam to clay loam materials. Also included in this group are soils that have a sandy clay loam or clay loam subsoil, more than 10 inches thick, that is underlain by stratified gravel and sand.

The soils in this group are placed in soil management units according to their percentage of slope and degree of erosion. The slope range of a unit is designated by adding a capital letter to the group symbol. In group 3a, the capital letters and the slopes they stand for are:

A——0 to 2 or 0 to 3 percent slopes (nearly level).
B——2 to 6 or 3 to 8 percent slopes (gently sloping).
C——6 to 12 or 8 to 15 percent slopes (moderately sloping).
D——12 to 18 or 15 to 25 percent slopes (strongly sloping).
E——15+ percent slopes (steep).

The main management needs of the soils in group 3a are the control of water erosion and application of practices to improve moisture-holding capacity and fertility. The hazard of wind erosion on these soils is slight to moderate. These sandy loam soils tend to lump and clod less than the more clayey soils. If their organic matter is depleted, however, the soils tend to erode during rains and to compact and crust after rains. At times this crust is so hard that plants have difficulty penetrating it. These soils are naturally well aerated. Good aeration is desirable for plant growth, but it also causes rapid decomposition of organic matter.

Except in steep areas, these soils are suited to all crops grown in the area if adequate fertilizer and lime are applied. These soils are not so well suited to sugar beets and field beans as are those in group 2a. More sod crops, legumes, and grasses generally are grown on these soils than on the soils in group 2a. These soils have lower natural fertility, lower moisture-holding capacity, and a greater erosion hazard than the soils in group 2a. The steep and badly eroded areas are best suited to permanent vegetation, either sod crops or trees. Some of the better adapted species for planting are red pine, white pine, Austrian pine, ponderosa pine, white spruce, Norway spruce, Scotch pine, and native hardwoods.

In table 11, crop rotations are suggested for each soil management unit. These rotations are the least protective that can be recommended for safe use under the named practices for control of water erosion. The rota-

TABLE 11.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water-erosion control, for the soil management units in group 3a*

Soil management unit	Slope	Erosion	Practices of water-erosion control			
			None	Contour tillage	Stripcropping	Terracing
	Percent					
3aA(IIS)	0–2 0–3	Slight and moderate	ARgmROgmW [1] (72).[2]	Not used	Not used	Not used.
3aB(IIS)	2–6 3–8	Slight, moderate, and severe.	AARO(86)	AROgmW(80)	AAARRO(80)	ARgmROgmW (72).
3aC(IIIS)	6–12 8–15	Slight and moderate	AW(94)	AAOW(93)	AARO(86)	AAROgmRO(76).
3aD(IVS)	12–18 15–25	Slight and moderate	AAW(97)	AAW(97)	AAWO(92)	Not recommended.
3aE(VIS)	15+	Severe	Permanent vegetation (grass or trees).			

[1] Rotation symbols: A, legume-grass; gm, green manure; O, spring grains; R, row crops; and W, winter grains. These symbols are the same as those in table 4. Rotations are recommended on the assumption that all crop residues, at least 2 tons per acre, are returned to the soil and plowed under immediately before planting.

[2] Number in parentheses refers to the relative protectiveness of the cropping system. A cropping system that has a greater value of relative protectiveness than the one given also can be used for any particular soil management unit and erosion control practice.

tions listed in table 4 that have a value of relative protectiveness less than those in table 11 do not adequately protect the soil if it is managed under the practices listed. Rotations having a greater value do adequately protect the soil. The amount of protection needed may be affected by minimum tillage, the removal of crop residues, and other management practices. The protection needed decreases with a decrease in slope and as additional management is used. Management should include using alfalfa-grass in the rotation, plowing under crop residues, and applying all available manure to the soil.

Fertilizer ratios, grades, and rates of application should be selected according to the crop to be grown, the kind of soil, and the results of soil tests. In table 12, for named crops, are ratios, grades, and rates of application of fertilizer suggested for the soils in group 3a. All soils should be tested before fertilizer is applied.

The soils of management group 3a need lime. Apply lime at rates indicated by soil tests and by the texture of the plow layer. Tests for lime should be made for every rotation. Lime should be applied 6 months or more before a legume is seeded.

Because of the wide range in slope in this management unit, the hazard of water erosion varies greatly. On the longer, more uniform slopes, such erosion-control practices as contour tillage, stripcropping, and terracing are effective. Artificial drainage generally is needed only to intercept seepage in some wet places along slopes. Interceptor tile should be placed at depths of 3 to 4 feet. Waterways that are likely to erode should be kept in grass to prevent gullies and washes from forming.

Because these soils contain little natural organic matter, organic matter should be supplied so that the moisture-holding capacity is kept high and the hazard of erosion is lessened. The importance of maintaining organic matter in these soils cannot be overemphasized.

Good tilth generally is not difficult to maintain in soils of management group 3a. Tillage should be the minimum needed to control weeds, provide adequate seedbeds, and permit water to penetrate the soil and allow seedlings to emerge.

SOIL MANAGEMENT UNIT 3aA(IIS)

Nearly level, slightly eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

MaA1 McBride fine sandy loam, 0 to 2 percent slopes, slightly eroded.
MbA1 McBride sandy loam and Montcalm loamy sand, 0 to 3 percent slopes, slightly eroded.
NaA1 Newaygo sandy loam, 0 to 2 percent slopes, slightly eroded.

These soils are moderately fertile and have moderately rapid permeability. They are nearly level and are not susceptible to water erosion. In some places they are eroded by wind. The water-holding capacity is moderate to moderately low. In extended dry periods, crops are affected by lack of moisture.

These soils are well suited to corn, small grains, and legume-grasses. They are not so well suited to sugar beets and field beans as to other crops. The animal-carrying capacity of pastures ranges from fair to moderately good, depending on the kinds of legumes and grasses grown and the amounts of fertilizer and lime applied. Only a limited acreage of these soils is in trees. White pine, Austrian pine, red pine, and Scotch pine grow well and will produce moderately high yields.

If all crop residues are returned to the soil, a suggested 5-year rotation is a legume-grass, a row crop seeded to a green-manure crop, a row crop, a spring grain seeded to a green-manure crop, and a winter grain crop seeded to a legume-grass (72) (see table 11). Other rotations are given in table 4. Any cropping system that has a greater value of relative protectiveness than (72) also can be used for this soil management unit.

Return all residues to the soil and apply manure to improve structure and fertility. Apply lime and fertilizer in amounts and grades indicated by soil tests (see tables 5 and 12).

Expected yields per acre of important crops under prevailing management and improved management are:

TABLE 12.—*Recommended fertilization for*

[N stands for nitrogen, P_2O_5 for

Crops	If the soil tests— Low in phosphorus and low in potassium— Apply per acre— N	P₂O₅	K₂O	At rate and grade of [1]—	Low in phosphorus and high in potassium— Apply per acre— N	P₂O₅	K₂O
	Lb.	Lb.	Lb.		Lb.	Lb.	Lb.
Alfalfa,[2] alfalfa-brome,[2] clover and sweetclover	0	80	80	400 lb. of 0–20–20	0	80	40
Alfalfa after each harvest year [2]	0	45	90	300 lb. of 0–15–30	0	45	45
Grass without a legume	50	25	25	312 lb. of 16–8–8	50	25	0
Barley [3] or oats [3] with legume seeding	15	60	60	300 lb. of 5–20–20	15	60	30
Barley [3 4] or oats [3 4] without legume seeding	25	50	50	310 lb. of 8–16–16	25	50	25
Field beans [3 4]	15	60	60	300 lb. of 5–20–20	15	60	30
Soybeans [3 4]	10	40	40	200 lb. of 5–20–20	10	40	20
Sugar beets [3 4 5]	30	120	120	600 lb. of 5–20–20	30	120	60
Wheat [3] or rye [3] with legume seeding	20	80	80	400 lb. of 5–20–20	20	80	40
Wheat [3 4] or rye [4] without legume seeding	15	60	60	300 lb. of 5–20–20	15	60	30
Corn [4 6]	15	60	60	300 lb. of 5–20–20	15	60	30

[1] Rates and grades are examples of suggested fertilization. Other rates and grades can be used to obtain the suggested amounts of nitrogen, phosphoric acid, and potash.

[2] Apply fertilizer containing ½ percent boron if pH is more than 6.5.

[3] Where the soil pH is above 6.9 apply fertilizer containing 1 or 2 percent manganese.

Crop	*Prevailing management*	*Improved management*
Corn bushels	35	75
Beans bushels	12	22
Sugar beets tons	8	11
Wheat bushels	23	39
Oats bushels	34	68
Barley bushels	28	46
Alfalfa tons	1.9	3.0
Mixed hay tons	1.3	2.2

SOIL MANAGEMENT UNIT 3aB(IIS)

Gently sloping, slightly to severely eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

- MaB1 McBride fine sandy loam, 2 to 6 percent slopes, slightly eroded.
- MaB2 McBride fine sandy loam, 2 to 6 percent slopes, moderately eroded.
- MbB1 McBride sandy loam and Montcalm loamy sand, 3 to 8 percent slopes, slightly eroded.
- MbB3 McBride sandy loam and Montcalm loamy sand, 3 to 8 percent slopes, severely eroded.
- NaB1 Newaygo sandy loam, 2 to 6 percent slopes, slightly eroded.

The soils in this management unit are moderately low in moisture-holding capacity and in natural fertility. Because they are gently sloping, they are susceptible to water erosion.

Under good management, these soils are well suited to crops, pasture, and trees. Yields of crops and pasture are lower in years that have long dry periods. Most crops grown in the county are suitable. Sugar beets and field beans, however, are not so well suited as on the finer textured soils of group 2a. Woodlots that are properly managed produce moderately high yields. The species most suitable for planting are white, Austrian, red, and Scotch pines.

If erosion control practices are not used, rotations should include legumes and grasses at least 2 years out of 4 (86) (see table 11). Under contour tillage, a suitable 4-year rotation is one that provides a legume-grass, a row crop, a small grain seeded to a green-manure crop, and a small grain seeded to a legume-grass (80). If these soils are stripcropped, row crops can be grown 2 years out of 6 (80). With terraces, use a 5-year rotation consisting of a legume-grass, corn followed by a green-manure crop, a row crop, and a spring grain seeded to a green-manure crop, and wheat seeded to legume-grass (72). Other suitable rotations are listed in table 4. Any cropping system that has a value of relative protectiveness greater than the one given in table 11, under the various practices, also can be used on this soil management unit.

Return all crop residues to the soil and use green-manure crops whenever practical. Keep all natural waterways in sod. Apply lime and fertilizers in amount indicated by soil tests for the named crops (see tables 5 and 12). If row crops are grown, some practices to reduce water erosion are needed. Legume-grasses generally need lime because the upper horizons of these soils are acid.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	*Prevailing management*	*Improved management*
Corn bushels	35	75
Beans bushels	12	22
Sugar beets tons	8	11
Wheat bushels	23	39
Oats bushels	34	68
Barley bushels	28	46
Alfalfa tons	1.9	3.0
Mixed hay tons	1.3	2.2

soil management groups 3a, 3b, 3c, L3b, and L3c

phosphoric acid, and K_2O for potash]

If the soil tests—Continued								
Low in phosphorus and high in potassium—Continued	High in phosphorus and low in potassium—				High in phosphorus and high in potassium—			
At rate and grade of [1]—	Apply per acre—			At rate and grade of [1]—	Apply per acre—			At rate and grade of [1]—
	N	P_2O_5	K_2O		N	P_2O_5	K_2O	
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	
400 lb. of 0-20-10	0	40	80	270 lb. of 0-15-30	0	40	40	200 lb. of 0-20-20.
225 lb. of 0-20-20	0	30	90	300 lb. of 0-10-30	0	22	45	150 lb. of 0-15-30.
150 lb. of 33-0-0 plus 125 lb. of 0-20-0.	50	0	25	150 lb. of 33-0-0 plus 40 lb. of 0-0-60.	50	0	0	150 lb. of 33-0-0.
300 lb. of 5-20-10	15	30	60	300 lb. of 5-10-20	15	30	30	190 lb. of 8-16-16.
250 lb. of 10-20-10	12	25	50	250 lb. of 5-10-20	25	25	25	250 lb. of 10-10-10.
300 lb. of 5-20-10	15	30	60	300 lb. of 5-10-20	15	30	30	190 lb. of 8-16-16.
200 lb. of 5-20-10	10	20	40	200 lb. of 5-10-20	10	20	20	125 lb. of 8-16-16.
600 lb. of 5-20-10	30	60	120	600 lb. of 5-10-20	30	60	60	375 lb. of 8-16-16.
400 lb. of 5-20-10	20	40	80	400 lb. of 5-10-20	20	40	40	250 lb. of 8-16-16.
300 lb. of 5-20-10	15	30	60	300 lb. of 5-10-20	15	30	30	190 lb. of 8-16-16.
300 lb. of 5-20-10	15	30	60	300 lb. of 5-10-20	15	30	30	190 lb. of 8-16-16.

[4] Supplemental nitrogen may be needed.
[5] Apply fertilizer containing ¼ percent boron if pH is more than 6.5.
[6] If corn is planted year after year, apply yearly to soils low in fertility 100 pounds of nitrogen, 50 pounds of phosphoric acid, and 50 pounds of potash per acre.

SOIL MANAGEMENT UNIT 3aC(IIIS)

Moderately sloping, slightly to severely eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

- MaC1 McBride fine sandy loam, 6 to 12 percent slopes, slightly eroded.
- MaC2 McBride fine sandy loam, 6 to 12 percent slopes, moderately eroded.
- MbC1 McBride sandy loam and Montcalm loamy sand, 8 to 15 percent slopes, slightly eroded.
- MbC2 McBride sandy loam and Montcalm loamy sand, 8 to 15 percent slopes, moderately or severely eroded.
- NaC1 Newaygo sandy loam, 6 to 12 percent slopes, slightly eroded.
- NaC2 Newaygo sandy loam, 6 to 12 percent slopes, moderately eroded.

These soils can be used for most crops grown in the county except sugar beets. Under good management, yields are moderate. All grasses and legumes grown in the county are well suited. Pasture produces good yields if lime and fertilizer are applied in amounts indicated by soil tests. Yields will be lower in dry periods. Under good management, well-stocked woodlands produce high to moderately high yields. White, Austrian, red, and Scotch pines are recommended for planting on these soils.

Varied crop rotations and soil conservation practices are needed to reduce water erosion on these moderately sloping soils. Where only contour tillage is used, small grains can be grown 2 out of 4 years, provided legume-grass completes the rotation (93). If the soils are stripcropped, keep them in sod crops half of the time (86) (see table 11). Where terraced, an adequate rotation consists of 2 years of legume-grass followed by 1 year of a row crop, 1 year of a spring grain seeded to a green-manure crop, another year of a row crop, and 1 year of a spring grain seeded to legume-grass (76). If erosion control practices are not used, keep the soil in legume-grass at least half of the time (94). Row crops are not recommended unless these soils are tilled on the contour, stripcropped, or terraced. Other suitable rotations are listed in table 4. Any cropping system that has a value of relative protectiveness greater than the one given under the specific practices in table 11 for this soil management unit also can be used.

Keep all natural waterways in sod to prevent gullying. Return all crop residues to the soil. Apply lime and fertilizer in amounts indicated by soil tests for named crops (see tables 5 and 12).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	30	65
Wheat	bushels	21	35
Oats	bushels	31	62
Barley	bushels	25	42
Alfalfa	tons	1.6	2.3
Mixed hay	tons	1.2	2.0

SOIL MANAGEMENT UNIT 3aD(IVS)

Strongly sloping, slightly to moderately eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

- MaD1 McBride fine sandy loam, 12 to 18 percent slopes, slightly eroded.
- MaD2 McBride fine sandy loam, 12 to 18 percent slopes, moderately eroded.
- MbD1 McBride sandy loam and Montcalm loamy sand, 15 to 25 percent slopes, slightly eroded.

These strongly sloping soils are suited to only a few crops. They are not suited to ordinary row crops. They are fairly well suited to legumes and grasses, but yields are low in dry periods. If lime and fertilizer are applied in amounts indicated by soil tests, most legumes and grasses grow well. These soils are well suited to trees. For new plantings, red, white, Austrian, and Scotch pines are recommended.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Wheat______________bushels__	21	35
Oats_______________bushels__	30	60
Barley______________bushels__	25	40
Alfalfa________________tons__	1. 5	2. 7
Mixed hay______________tons__	1. 2	1. 8

SOIL MANAGEMENT UNIT 3aE(VIS)

Strongly sloping or steep, moderately or severely eroded, light-colored, moderately coarse textured, well-drained, somewhat droughty soils

MaD3 McBride fine sandy loam, 12 to 18 percent slopes, severely eroded.
MbE3 McBride sandy loam and Montcalm loamy sand, 15+ percent slopes, moderately or severely eroded.

Where these soils have been cropped, moderate to severe sheet and gully erosion have occurred. The main managment need is the control of water erosion.

These soils are not suited to row crops and small grains. The best use is permanent vegetation—legumes, grasses, or trees. Yields of wood products from established woodlots are good. For new plantings, use white pine, Austrian pine, or ponderosa pine.

To reestablish pasture, break the ground, fertilize, and seed legumes and grasses with a small-grain nurse crop. Apply lime and fertilizer in amounts indicated by soil tests for named crops (see tables 5 and 12).

Soil management group 3b

This soil management group consists of moderately dark colored, moderately coarse textured soils that formed from parent materials of sandy loam or stratified very fine sand and silt under imperfect drainage. Some soils in this group have a sandy clay loam or clay loam subsoil more than 10 inches thick that is underlain by stratified gravel and sands at depths of 24 to 42 inches. Also included are fine sands, very fine sands, and silts, 18 to 42 inches thick, over loam to silty clay loam materials.

The soils in this group are placed in management units according to percentage of slope, which is designated by a capital letter following the symbol for the soil management group. In group 3b, the capital letters and the slope ranges are:

A____________0 to 2 percent slopes (nearly level).
B____________2 to 6 or 2 to 7 percent slopes (gently sloping).
C____________7 to 14 percent slopes (sloping).
D____________14+ percent slopes (strongly sloping).

The soils in management group 3b have moderate moisture-holding capacity. They are naturally fertile and are seldom eroded by wind or water. The main management needs are adequate drainage and maintenance of soil structure and fertility. Some soils in this group are covered by deposits of coarse-textured, less fertile materials that washed from surrounding slopes.

All field crops of the county are grown on these soils. Yields normally are not so high as those on the soils of management group 2b. Where these soils are not adequately drained, crops are limited to legumes, grasses, and crops that are planted late. Trees are seldom planted.

Select fertilizer ratios, grades, and rates of application according to the crops to be grown, the kinds of soil, and the results of soil tests. In table 12 rates and grades for fertilizer are given. All soils should be tested before fertilizer and lime are applied.

Where outlets are adequate, tile lines placed at 4 to 7 rod intervals and at depths of 3 to 4 feet generally will increase crop yields. If tile is laid in sand, special blinding must be used to keep sandy material from sifting through the joints into the tile.

Tillage should be the minimum that will control weeds, provide an adequate seedbed, and maintain the plow layer in a condition that permits water to penetrate and seedlings to emerge.

SOIL MANAGEMENT UNIT 3bA(IIW)

Nearly level, moderately dark colored, moderately coarse textured soils formed under imperfect drainage

CfA0 Coral fine sandy loam, 0 to 2 percent slopes.
McA0 McGregor sandy loam, 0 to 2 percent slopes.
RaA0 Richter and Tonkey bouldery sandy loam and loam, 0 to 2 percent slopes.
SaA0 Sanilac silt loam, 0 to 2 percent slopes.
SbA0 Saverine and Iosco fine sandy loams, 0 to 2 percent slopes.

These soils are suited to all field crops grown in the county. If maximum yields are to be obtained, these soils need to be artificially drained and the crops grown in recommended rotations. If drainage is adequate, yields are moderately high to high. The kinds of legumes and grasses grown depend on the wetness of the soil. Trees generally are not planted, although farm woodlots are common. Trees suitable for the better drained areas are white pine, Austrian pine, red pine, Scotch pine, and Norway spruce.

Where the soils are adequately drained, a suitable 5-year rotation consists of a legume-grass mixture, corn planted with a cover crop, a row crop, a spring grain followed by a green-manure crop, and wheat (72). Yields are generally higher if fewer row crops are grown in a rotation. Other suggested rotations are listed in table 4. Any rotation with a value of relative protectiveness greater than (72) also can be used with this soil management unit.

Return all crop residues to the soil to maintain fertility. After the soils are tested, apply fertilizer in amounts indicated in table 12 for named crops. Apply lime according to soil tests in amounts indicated for light-colored soils in table 5.

The soils can be adequately drained by tile lines spaced 4 to 7 rods apart and laid at depths of 36 to 48 inches. The tile should be covered with topsoil, straw, or other backfill materials that will keep the sand from sifting into the tile. In other places, only random tiling is needed. The

laying of tile in particularly wet areas has to be delayed until dry periods.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ____ bushels	45	80
Beans ____ bushels	16	25
Sugar beets ____ tons	9	14
Wheat ____ bushels	25	42
Oats ____ bushels	40	80
Barley ____ bushels	30	50
Alfalfa ____ tons	2. 0	3. 3
Mixed hay ____ tons	1. 5	2. 6

SOIL MANAGEMENT UNIT 3bB(IIW)

Gently sloping, slightly to moderately eroded, moderately dark colored, moderately coarse textured soils formed under imperfect drainage

CfB1 Coral fine sandy loam, 2 to 6 percent slopes, slightly eroded.

McB1 McGregor sandy loam, 2 to 6 percent slopes, slightly eroded.

RoB1 Richter and Tonkey bouldery sandy loam and loam, 2 to 6 percent slopes, slightly eroded.

SaB1 Sanilac silt loam, 2 to 6 percent slopes, slightly eroded.

SbB1 Saverine and Iosco fine sandy loams, 2 to 7 percent slopes, slightly eroded.

SbB2 Saverine and Iosco fine sandy loams, 2 to 7 percent slopes, moderately eroded.

These soils are moderately well supplied with plant nutrients and have moderate water-holding capacity. Drainage and droughtiness are the main problems.

The soils in this unit are suited to all crops grown in the county. To obtain maximum yields, artificial drainage and proper crop rotations are needed. Adequately drained areas are suited to legumes and grasses. Although farm woodlots are common, trees generally are not planted. On adequately drained areas, plant white pine, red pine, Scotch pine, or Norway spruce.

The soils can be adequately drained by tile lines spaced 4 to 7 rods apart and laid at depths of 36 to 48 inches. Cover the tile with topsoil, straw, or other backfill materials to keep sand from sifting through the joints and filling the tile lines. Because of slope, special care must be used in laying tile. In extremely wet places, it may be necessary to delay this work until dry periods. In other places only random tiling is needed. Drainage is more difficult than in soil management unit 3bA(IIW).

Where the soils are adequately drained, a suitable 5-year rotation consists of a legume-grass mixture, corn planted with a cover crop, a row crop, a spring grain followed by a green-manure crop, and wheat (72). Yields are higher if fewer row crops are grown in the cropping sequence. Other crop rotations are given in table 4. Any rotation in that table having a value of relative protectiveness greater than (72) also can be used with this soil management unit.

Return all crop residues to the soil. Apply fertilizer in amounts indicated by soil tests (see table 12). After the soils have been tested, apply lime at the rates recommended for light-colored soils in table 5.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ____ bushels	45	80
Beans ____ bushels	16	25
Sugar beets ____ tons	9	14
Wheat ____ bushels	25	42
Oats ____ bushels	40	80
Barley ____ bushels	30	50
Alfalfa ____ tons	2. 0	3. 3
Mixed hay ____ tons	1. 5	2. 6

SOIL MANAGEMENT UNIT 3bC(IIIW)

Moderately sloping, slightly to moderately eroded, moderately dark colored, moderately coarse textured soils formed under imperfect drainage

SbC1 Saverine and Iosco fine sandy loams, 7 to 14 percent slopes, slightly eroded.

SbC2 Saverine and Iosco fine sandy loams, 7 to 14 percent slopes, moderately eroded.

These soils contain a moderately large amount of organic matter and have moderate moisture-holding capacity. Drainage and control of water erosion are the main management needs. The laying of tile drains, however, is difficult because of the slope.

Most field crops grown in the county are suited to these soils, but sugar beets and field beans are seldom grown. Yields of forage crops are moderate if adapted legumes and grasses are grown and if fertilizers are applied in amounts and grades indicated by soil tests (see table 12) for named crops. Yields of woodland products are low to moderate. Trees are seldom planted.

If erosion control practices are not used, a suitable rotation is 1 year of alfalfa followed by wheat (94). If contour tillage is used, a suitable rotation is 3 years of alfalfa, followed by a row crop and oats (88). If drainage type terraces are used, an appropriate rotation is 1 year of alfalfa, 1 year of a row crop seeded to green manure, 1 year of a row crop, 1 year of oats seeded to green manure, and wheat (72). Other suggested rotations are listed in table 4. Any crop rotation with a relative protectiveness greater than the one given for the respective erosion control practices just mentioned can be used with this soil managment unit.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ____ bushels	30	65
Beans ____ bushels	10	20
Wheat ____ bushels	21	35
Oats ____ bushels	31	62
Barley ____ bushels	25	42
Alfalfa ____ tons	1. 6	3. 0
Mixed hay ____ tons	1. 2	2. 2

SOIL MANAGEMENT UNIT 3bD(IVE)

Strongly sloping, slightly to moderately eroded, moderately dark colored, moderately coarse textured soils formed under imperfect drainage.

SbD1 Saverine and Iosco fine sandy loams, 14+ percent slopes, slightly eroded.

SbD2 Saverine and Iosco fine sandy loams, 14+ percent slopes, moderately eroded.

These soils occur in small areas along dissected drainageways, and the total acreage in the county is small. Loam to silty clay loam till underlies the fine sands, very fine sands, and silts at depths of 18 to 42 inches.

These soils are not recommended for intertilled crops. Areas that have been cultivated are normally moderately eroded. Forage crops are suitable, and most areas are used for permanent pasture.

Soil management group 3c

This soil management group consists of nearly level to gently sloping, dark-colored soils that developed from stratified very fine sands, silts, and sandy loams under poor drainage.

The soils in this group are productive and have good moisture-holding capacity. They contain a large amount of organic matter and generally have good natural fertility. Their management needs are adequate drainage and the maintenance of fertility.

If adequately drained, these soils are suited to all crops commonly grown in the county. Normally, yields are not so high as those on the soils of soil management group 2c. Only grasses and legumes are recommended for areas that are not artificially drained. Trees are seldom planted.

Lime is seldom needed on these soils. These dark-colored soils need 50 percent more lime than that recommended in table 5 for light-colored soils. These neutral to calcareous soils generally are deficient in manganese and boron. Additions of these elements in fertilizers may be needed for some crops.

In table 12, for named crops, are recommended ratios, grades, and rates of application of fertilizers for the soils in this group. All soils should be tested before lime and fertilizer are applied.

Where outlets are adequate, satisfactory drainage is provided by tile lines spaced 4 to 7 rods apart and laid at depths of 36 to 48 inches. Special blinding to prevent sand from sifting into the lines generally is needed. Tile drainage generally increases crop yields.

Tillage should be the minimum that will control weeds, provide an adequate seedbed, and maintain tilth and soil structure that permit water to penetrate the soil and seedlings to emerge.

SOIL MANAGEMENT UNIT 3cA(IIW)

Nearly level to gently sloping, dark-colored, medium to moderately coarse textured soils developed under poor drainage

BaA0 Bach silt loam, 0 to 2 percent slopes.
TfA0 Tonkey sandy loam, 0 to 2 percent slopes.
TgA0 Tonkey and Bach fine sandy loams, 0 to 2 percent slopes.
TgB1 Tonkey and Bach fine sandy loams, 2 to 7 percent slopes, slightly eroded.

These soils need both artificial drainage and suitable crop rotations if they are to produce maximum yields. They are suited to the field crops grown in the county. Yields of forage crops are moderately high to high where selected varieties are grown and the soils are adequately fertilized. Woodlands have low to moderate yields, depending on drainage. Trees are seldom planted on these soils.

Crop rotations should be used that provide green-manure crops. A suitable rotation consists of a legume-grass, a row crop followed by a green-manure crop, a row crop, spring grain followed by a green-manure crop, and wheat (72). Other rotations are given in table 4. Any rotation in that table having a value of relative protectiveness greater than (72) also can be used on this soil management unit. Return all crop residues to the soil.

These soils can be adequately drained by tile lines spaced 4 to 7 rods apart and laid at depths of 36 to 48 inches. Special blinding material is needed for backfill over the tile. In places, tile should not be laid until dry periods.

In table 12, for named crops, are recommended ratios, grades, and rates of application of fertilizers when soil tests have been made.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	50	85
Beans	bushels	18	27
Sugar beets	tons	10	15
Wheat	bushels	27	45
Oats	bushels	40	80
Barley	bushels	33	55
Alfalfa	tons	2. 2	3. 4
Mixed hay	tons	1. 7	2. 4

Soil management group 4a

This soil management group consists of well to moderately well drained, light-colored soils that developed from loamy sand to sandy loam parent materials or on stratified sands and gravel. The sands and gravel occur at depths of 18 to 42 inches and are overlain by a sandy loam to coarse sandy clay loam subsoil that is as much as 10 inches thick. Also in this management group are well to moderately well drained sands to loamy sands underlain by loam to silty clay loam materials at depths of 18 to 42 inches.

The soils in this group are placed in management units according to degree of erosion and percentage of slope, which is designated by a capital letter that follows the group symbols. In group 4a the capital letters and the slope ranges are:

A--------0 to 2 or 0 to 3 percent slopes (nearly level).
B--------2 to 6 or 3 to 8 percent slopes (gently sloping).
C--------6 to 12, 7 to 14, or 8 to 15 percent slopes (moderately sloping to strongly sloping).
D--------12 to 18 or 14+ percent slopes (very strongly sloping).
E--------15+ percent slopes (steep).

In group 4a are some of the soils of Sanilac County that have little natural productivity. These soils need management that reduces water and wind erosion and maintains or increases moisture-holding capacity, organic matter, and fertility.

Except on steep slopes, these soils are best suited to deep-rooted crops, small grains, and short-season crops. To reduce wind erosion and maintain the supply of organic matter, more legume-grass crops are needed on these soils than on finer textured ones. Special crops have been grown successfully on nearly level and gently sloping areas that are irrigated and intensely managed. Where properly fertilized and seeded, the more sloping areas are suited to legumes and grasses. Steep or eroded areas are generally planted to trees. Among the species recommended for reforestation are red pine, Scotch pine, and jack pine.

In table 13 is shown the least protective cropping system that can be safely used for the soils of group 4a, under named practices of water-erosion control. Any

TABLE 13.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water-erosion control, for the soil management units in group 4a*

Soil management unit	Slope	Erosion	Practices of water-erosion control			
			None	Contour tillage	Stripcropping	Terracing
	Percent					
4aA(IIS)	0–2 0–3	Slight	AAROW [1] (85) [2]	Not used	Not used	Not used.
4aB(IIS)	2–6 3–8	Slight and moderate	AAROW(85)	AAROW(85)	AARW(87)	AAROW(85).
4aC(IIS)	6–12 7–14 8–15	Slight and moderate	AW(94)	AAARW(90)	AARW(87)	AAROW(85).
4aD(IVS)	12–18 14+	Slight and moderate	AAW(97)	AAW(97)	Not used	Not recommended.
4aE(VIIS)	15+	Slight, moderate, and severe	Permanent vegetation (grass or trees).			

[1] Rotation symbols: A, legume-grass; O, spring grain; R, row crop; W, winter grain. These symbols are the same as those used in table 4. Rotations are recommended on the assumption that all crop residues, at least 2 tons per acre, are returned to the soil and plowed under immediately before planting.

[2] Number in parentheses refers to the relative protectiveness of the cropping system. Any cropping system that has a value of relative protectiveness greater than the one given for a particular soil management unit and erosion control practice also can be used (see table 4).

rotation in table 4 that has a value of relative protectiveness greater than those shown in table 13, under the listed water-control practices, will also be satisfactory.

Lime is generally needed on these soils. Apply lime in amounts indicated by soils tests, preferably 6 months before legumes are seeded (see table 5). Select fertilizer ratios, grades, and rates of application according to the crops to be grown, the kinds of soil, and the results of soil tests. In table 14 are recommended rates of fertilization for named crops.

If these soils are bare, they may be severely eroded by wind and water. Tillage should be completed quickly and should be the minimum that will control weeds, provide an adequate seedbed, and maintain soil structure. On cultivated fields, use windbreaks to reduce wind erosion or plant, in alternate strips, sod crops and small grain or sod crops and row crops. The strips should be at right angles to the prevailing winds. Protect waterways with a sod cover. Use a field cultivator on sloping hay or pasture areas that are being prepared for grain or for reseeding. Leave crop residues on the surface to reduce erosion.

In many places where they have been cropped under poor management, these sandy soils need a positive soil-building program. One such program that has been successful provides for planting a series of green-manure crops that are fertilized for abundant growth.[7] This program calls for tilling or cultivating the soil through the summer so that weeds are controlled. Plant rye late in summer. If soil tests show that plant nutrients are low, apply 350 pounds of 4-16-16 fertilizer per acre. Allow the rye to grow through the fall and winter until late in spring. In April, apply 40 pounds of elemental nitrogen per acre. Plow the rye under when it is 12 to 18 inches high. Then prepare a seedbed and plant buckwheat at the rate of 1½ bushels per acre. If soil tests show that plant nutrients are still low when the buckwheat is planted, apply another 350 pounds of 4-16-16 fertilizer per acre. Plow the buckwheat under at full-blossom stage. About the middle of August, prepare a seedbed and sow alfalfa-bromegrass that has a bushel of oats added for each acre. When the alfalfa sod is established, the restoration of the soil should be about complete and a cropping system that will conserve the soil and maintain productivity can be planned.

[7] Suggested by ORVILLE WALKER, county extension director, Kalkaska County, Mich.

SOIL MANAGEMENT UNIT 4aA(IIS)

Nearly level, slightly eroded, light-colored, coarse-textured, well-drained, droughty soils

MeA1 Mancelona loamy sand, 0 to 3 percent slopes, slightly eroded.

MnA1 Montcalm loamy sand, 0 to 2 percent slopes, slightly eroded.

These soils are low in natural fertility. They are susceptible to wind erosion. If they are not properly managed, the organic matter burns out and the sandy material blows away.

Although yields of sugar beets and beans are low, these soils can be used for all field crops generally grown in the county. Because of the moderately low moisture-holding capacity, pastures are only fair, especially in summer. Deep-rooted, drought-resistant legumes and grasses give the best yields. Crops grow well in spring because these sandy soils warm quickly. White, red, jack, and Scotch pines grow well and are recommended for new plantings.

If these soils are used for crops, control of wind erosion is needed. Windbreaks or wind stripcropping combined with the use of rotations that provide adequate legume-grasses will reduce erosion. A satisfactory rotation consists of 2 years of legume-grass, 1 year of a row crop, and 2 years of small grain (85). Another suggested rotation is 2 years of legume-grass, 1 year of a row crop, and 1 year of a small grain seeded to legume-grass (86). Cover

TABLE 14.—*Recommended fertilization for*

[N stands for nitrogen, P_2O_5 for

Crops	If the soil tests—						
	Low in phosphorus and low in potassium—				Low in phosphorus and high in potassium—		
	Apply per acre—			At rate and grade of [1]—	Apply per acre—		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*
Alfalfa,[2] alfalfa-brome,[2] clover, and sweetclover	0	60	60	300 lb. of 0-20-20	0	60	30
Alfalfa after each harvest year [2]	0	45	90	300 lb. of 0-15-30	0	45	45
Grass without a legume	50	25	25	312 lb. of 16-8-8	50	25	0
Barley [4] or oats [4] with legume seeding	12	50	50	250 lb. of 5-20-20	12	50	25
Barley [3 4] or oats [3 4] without legume seeding	16	32	32	200 lb. of 8-16-16	16	32	16
Field beans [3 4] and soybeans [3 4]	10	40	40	200 lb. of 5-20-20	10	40	20
Wheat [4] or rye [5] with legume seeding	15	60	60	300 lb. of 5-20-20	15	60	30
Wheat [3 4] or rye [3] without legume seeding	12	50	50	250 lb. of 5-20-20	12	50	25
Corn [3]	10	40	40	200 lb. of 5-20-20	10	40	20

[1] Rates and grades are examples of recommended fertilization. Other rates and grades can be used to obtain the suggested amounts of nitrogen, phosphoric acid, and potash.

[2] Apply fertilizer containing ½ percent boron if pH is above 6.5.

crops, or green-manure crops, seeded in corn or other row crops and in small grains also will reduce wind erosion.

Other suggested crop rotations are listed in table 4. Any cropping system that has a value of relative protectiveness greater than (85) also can be used on this soil management unit.

Return all crop residues to the soil. Apply lime and fertilizer in the amounts indicated by soil tests (see tables 5 and 14).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	28	55
Beans	bushels	10	15
Sugar beets	tons	5	9
Wheat	bushels	20	32
Oats	bushels	30	55
Barley	bushels	22	35
Alfalfa	tons	1.5	2.8
Mixed hay	tons	1.0	1.8

SOIL MANAGEMENT UNIT 4aB(IIIS)

Gently sloping, slightly to moderately eroded, light-colored, coarse-textured, well-drained, droughty soils

MeB1 Mancelona loamy sand, 3 to 8 percent slopes, slightly eroded.

MeB2 Mancelona loamy sand, 3 to 8 percent slopes, moderately eroded.

MnB1 Montcalm loamy sand, 2 to 6 percent slopes, slightly eroded.

MnB2 Montcalm loamy sand, 2 to 6 percent slopes, moderately eroded.

These sandy soils can be used for field crops, pasture, or trees. Crop yields are only fair, however, because these soils are low in fertility and in moisture-holding capacity and are susceptible to both wind and water erosion. They are best suited to crops that are resistant to prolonged drought. Sugar beets and beans are not suitable. These soils produce only fair pasture that has a low animal carrying capacity. If adequate amounts of lime and fertilizers are applied, all legumes and grasses grown in the county are suitable. Yields of trees are medium to low. For new plantings use white, red, jack, or Scotch pines.

These soils are suited to crops only if wind and water erosion are controlled. Wind erosion can be reduced by the use of windbreaks or stripcropping, or by a combination of these practices. If stripcropping is used, keep the soils in legume-grasses at least half the time (87) (see table 13). If water control practices are not used, a suitable 5-year rotation consists of 2 years of a legume-grass, a row crop, a spring grain, and a winter grain seeded to a legume-grass (85). This rotation will reduce erosion and maintain productivity. Other suggested rotations are listed in table 4. Any crop rotation with a value of relative protectiveness greater than the one given in table 13 for a specified erosion control practice can be used on this soil management unit.

Keep waterways in sod. Return all crop residues to the soil. Apply lime and fertilizers in amounts indicated by soil tests (see tables 5 and 14).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	25	50
Wheat	bushels	18	28
Oats	bushels	28	50
Barley	bushels	20	32
Alfalfa	tons	1.4	2.7
Mixed hay	tons	1.0	1.8

soil management groups 4a, 4b, and 4c

phosphoric acid, and K_2O for potash]

If the soil tests—Continued								
Low in phosphorus and high in potassium—Continued	High in phosphorus and low in potassium—				High in phosphorus and high in potassium—			
At rate and grade of [1]—	Apply per acre—			At rate and grade of [1]—	Apply per acre—			At rate and grade of [1]—
	N	P_2O_5	K_2O		N	P_2O_5	K_2O	
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	
300 lb. of 0–20–10	0	30	60	200 lb. of 0–15–30	0	30	30	150 lb. of 0–20–20.
225 lb. of 0–20–20	0	30	90	300 lb. of 0–10–30	0	22	44	150 lb. of 0–15–30.
150 lb. of 33–0–0 plus 125 lb. of 0–20–0.	50	0	25	150 lb. of 33–0–0 plus 40 lb. of 0–0–60.	50	0	0	150 lb. of 33–0–0.
250 lb. of 5–20–10	12	25	50	250 lb. of 5–10–20	12	25	25	150 lb. of 8–16–16.
160 lb. of 10–20–10	8	16	32	160 lb. of 5–10–20	16	16	16	160 lb. of 10–10–10.
200 lb. of 5–20–10	10	20	40	200 lb. of 5–10–20	10	20	20	125 lb. of 8–16–16.
300 lb. of 5–20–10	15	30	60	300 lb. of 5–10–20	15	30	30	190 lb. of 8–16–16.
250 lb. of 5–20–10	12	25	50	250 lb. of 5–10–20	12	25	25	150 lb. of 8–16–16.
200 lb. of 5–20–10	10	20	40	200 lb. of 5–10–20	10	20	20	125 lb. of 8–16–16.

[3] Supplemental nitrogen may be needed.

[4] Where pH is above 6.5 apply fertilizer containing 1 or 2 percent manganese.

SOIL MANAGEMENT UNIT 4aC(IIIS)

Moderately sloping, slightly to moderately eroded, light-colored, coarse-textured, well-drained, droughty soils

IcC1 Iosco sandy loam and Croswell loamy sand, 7 to 14 percent slopes, slightly eroded.
MeC1 Mancelona loamy sand, 8 to 15 percent slopes, slightly eroded.
MeC2 Mancelona loamy sand, 8 to 15 percent slopes, moderately eroded.
MmC1 Menominee loamy sand, 6 to 12 percent slopes, slightly eroded.
MmC2 Menominee loamy sand, 6 to 12 percent slopes, moderately eroded.
MnC1 Montcalm loamy sand, 6 to 12 percent slopes, slightly eroded.
MnC2 Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded.

These droughty soils are low in fertility and are susceptible to both wind and water erosion. In many places, considerable erosion has occurred.

If properly managed, these soils can be used for crops or pasture, but yields will be lower than on most of the soils in the county. Sugar beets and beans are not recommended for these soils. If adequately limed and fertilized, these soils are suited to all legumes and grasses commonly grown in the county. They are fairly well suited to pasture, although yields are low in dry summers. Yields of forest products are low to moderate. White, red, jack, and Scotch pines are suitable for new plantings.

If these soils are cropped, wind and water erosion should be controlled. Wind erosion can be reduced by windbreaks or, when satisfactory crop rotations are used, by stripcropping. Where stripcropped, a suitable rotation is one that keeps these soils in legume-grass half the time but does not include a row crop more often than once in 4 years (87) (see table 13). A more protective rotation is needed if only contour tillage is used or if supporting practices to control erosion are not used (see table 13). Generally, terraces are not used where stripcropping adequately controls erosion. With terraces, an adequate rotation consists of 2 years of legume-grass, a row crop, and 2 years of small grain (85). Where erosion control practices are not used, row crops are not recommended. Cover crops should be grown as much of the time as possible. Other suggested rotations are listed in table 4. Any rotation in that table with a value of relative protectiveness greater than the one given for an erosion control practice in table 13 also can be used on this soil management unit.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	22	45
Wheat	bushels	18	24
Oats	bushels	27	45
Barley	bushels	15	30
Alfalfa	tons	1. 4	2. 3
Mixed hay	tons	. 9	1. 6

SOIL MANAGEMENT UNIT 4aD(IVS)

Strongly sloping, slightly to moderately eroded, light-colored, coarse-textured, well-drained, droughty soils

IcD1 Iosco sandy loam and Croswell loamy sand, 14+ percent slopes, slightly eroded.
MnD1 Montcalm loamy sand, 12 to 18 percent slopes, slightly eroded.
MnD2 Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded.

These soils are droughty, low in fertility, and highly susceptible to both wind and water erosion. Areas that have been cultivated are moderately eroded. In places the subsoil is exposed.

These soils are not well suited to intertilled crops. They are well suited to trees, and yields of forest products are moderate under good management. Red pine, white pine, Scotch pine, and jack pine are suitable for new plantings.

Where these soils are tilled on the contour, a rotation of 2 years of legume-grasses followed by winter grain every third year is satisfactory (97). Stripcropping generally is not used on these soils. Other rotations are suggested in table 4. Any crop rotation in that table with a value of relative protectiveness greater than (97) also can be used on this soil management unit.

Keep waterways in sod. Apply fertilizers and lime in amounts indicated by soil tests (tables 5 and 14). Return all crop residues to the soils.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	*Prevailing management*	*Improved management*
Wheat ---------- bushels --	14	20
Oats ---------- bushels --	22	40
Barley ---------- bushels --	12	28
Alfalfa ---------- tons --	1. 3	2. 3
Mixed hay ---------- tons --	. 8	1. 6

SOIL MANAGEMENT UNIT 4aE(VIIS)

Steep, slightly to severely eroded, light-colored, coarse-textured, well-drained, droughty soils

MeD1 Mancelona loamy sand, 15+ percent slopes, slightly eroded.
MeD2 Mancelona loamy sand, 15+ percent slopes, moderately eroded.
MeD3 Mancelona loamy sand, 15+ percent slopes, severely eroded.

These droughty soils are generally low in fertility. Many areas that were once cropped are now severely eroded. Unless these soils are kept in legumes or grasses, wind and water erosion are the major problems.

Although these soils are not recommended for crops grown in rotation, they can be used for legumes and grasses. Yields will be only fair, however, even where adequate amounts of lime and fertilizer are applied. Extreme care must be taken in reseeding pastures because of the hazard of erosion when the soils are tilled. Trees can be grown, but yields of forest products are moderate to moderately low. Use red, white, and Scotch pines for planting.

Soil management group 4b

This soil management group consists of the following: (1) Light to moderately dark-colored, coarse-textured soils that were developed from loamy sand parent materials under imperfect drainage; (2) imperfectly drained soils that have sandy loam or sandy clay loam subsoil, less than 10 inches thick, that is underlain by sands and gravel at depths of 18 to 42 inches; and (3) well drained to imperfectly drained sandy loams to loamy sands that are 18 to 42 inches thick over loam to silty clay loam materials. The light-colored, well-drained soils of this group occupy a limited acreage.

The soils in this group are placed in management units according to range of slope, which is designated by a capital letter that follows the group symbol. In group 4b, the capital letters and their slope ranges are:

A ---------- 0 to 2 percent slopes (nearly level).
B ---------- 2 to 6 or 2 to 7 percent slopes (gently sloping).

The soils in group 4b have moderately low moisture-holding capacity, and some of them are susceptible to wind erosion. They are not so productive as the soils in soil management group 3b.

These soils are best suited to sod crops, deep-rooted crops, winter grains, and short-season crops. Inadequately drained areas are suited only to pasture, hay, and crops that are planted late. Areas that are properly seeded and adequately fertilized are used for pasture and hay. Trees are seldom planted.

Fertilizer ratios, grades, and rates of application should be selected according to the crops to be grown, the kinds of soil, and the results of soil tests. In table 14 are suggested rates of fertilization for named crops. All soils should be tested before lime and fertilizer are applied.

Where outlets are adequate, these soils can be drained by tile lines. Tillage should be the minimum that will control weeds, provide an adequate seedbed, and keep the plow layer in a condition that will permit water to penetrate and seedlings to emerge.

SOIL MANAGEMENT UNIT 4bA(IIIW)

Nearly level, light to moderately dark colored, coarse-textured soils formed under good to imperfect drainage

GbA0 Gladwin and Palo sandy loams, 0 to 2 percent slopes.
IcA0 Iosco sandy loam and Croswell loamy sand, 0 to 2 percent slopes.
IaA0 Iosco and Menominee loamy sands, 0 to 2 percent slopes.
IbA0 Iosco and Winegars sandy loams, 0 to 2 percent slopes.
OaA0 Otisco loamy sand, 0 to 2 percent slopes.

Although these soils are wet part of the time, they have moderately low capacity for holding moisture that crops can use. They are moderately low in fertility and are susceptible to wind erosion.

If properly managed, these soils can be used for most crops grown in the county except sugar beets and beans. But even under improved management, yields are only moderate to moderately low. These soils are moderately well suited to forage crops, but the kinds of legumes and grasses grown depend on the wetness of the soils. Trees are seldom planted. Most species in existing woodlots are not desirable, and yields of forest products are low. Trees suited to the drier areas are white pine, Austrian pine, or Norway spruce. In many places, these imperfectly drained soils are used in the same way as adjacent well drained and moderately well drained soils.

A suitable rotation consists of 2 years of legume-grass, 1 year of a row crop, 1 year of a small grain, and 1 year of a small grain seeded to legume-grass (85). Other suggested rotations are listed in table 4. Any cropping system in this table that has a value of relative protectiveness greater than (85) also can be used on this soil management unit.

After the soils are tested, apply fertilizers as indicated for named crops in table 14. Apply lime as indicated by soil tests (see table 5).

Artificial drainage generally is needed for field crops. Open ditches or tile lines placed at 4 to 8 rod intervals and at depths of 36 to 48 inches are suitable. The grades for tile lines may be difficult to maintain on these soils because sand generally occurs at the depths where the tile should be laid. To keep the tile from filling with sand, cover it with topsoil, straw, or similar materials. It may be necessary to delay ditching and tiling until the dry period

of the year. Either windbreaks or wind stripcropping will reduce wind erosion, but a combination of these practices is more effective.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		Prevailing management	Improved management
Corn	bushels	35	65
Wheat	bushels	22	35
Oats	bushels	32	60
Barley	bushels	26	39
Alfalfa	tons	1.7	3.1
Mixed hay	tons	1.2	2.1

SOIL MANAGEMENT UNIT 4bB(IIIW)

Gently sloping, slightly eroded, light to moderately dark colored, coarse-textured soils formed under good to imperfect drainage

GbB1 Gladwin and Palo sandy loams, 2 to 7 percent slopes, slightly eroded.
Iosco sandy loam and Croswell loamy sand, 2 to 7 percent slopes, slightly eroded.
IaB1 Iosco and Menominee loamy sands, 2 to 6 percent slopes, slightly eroded.
Iosco and Winegars sandy loams, 2 to 6 percent slopes, slightly eroded.
OaB1 Otisco loamy sand, 2 to 6 percent slopes, slightly eroded.

Although they are wet some of the time, these soils have a moderately low capacity for holding moisture that crops can use. They are moderately low in fertility. Wind erosion is a problem, especially on the drier sites.

These soils are suited to all crops commonly grown in the county except sugar beets and beans. Yields are moderate to low, depending on the management used. Where adequately drained, these soils produce good legumes and grasses. The kinds of legumes and grasses seeded depend on the wetness of the soil. These soils are fair to poor for trees, which are seldom planted. Existing woodlots have undesirable species and low yields.

A suitable rotation consists of 2 years of legume-grass, 1 year of a row crop, 1 year of a small grain, and 1 year of a small grain seeded to legume-grass (85). Other rotations are given in table 4. Any cropping system in that table that has a value of relative protectiveness greater than (85) can also be used on this soil management unit.

Either windbreaks or wind stripcropping reduces wind erosion, but it is best to use a combination of the two practices. Special emphasis should be given to a fertility program and the use of green-manure crops. Return all crop residues to the soil.

Artificial drainage is needed if crops are to be grown in rotation. Use open ditches, random tile, or tile lines spaced at intervals of 4 to 8 rods. Sand will probably make it difficult to maintain the proper grade, particularly in these sloping areas. Cover the tile lines with topsoil, straw, or similar materials to keep the lines from filling with sand. It may be necessary to delay ditching or tiling until a dry period of the year.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		Prevailing management	Improved management
Corn	bushels	35	60
Wheat	bushels	22	35
Oats	bushels	30	60
Barley	bushels	23	39
Alfalfa	tons	1.7	3.1
Mixed hay	tons	1.2	2.1

SOIL MANAGEMENT UNIT 4/Rb(IVW)

Nearly level to moderately sloping, slightly eroded, moderately dark colored, moderately well to imperfectly drained soils with sandstone bedrock at depths of 18 to 42 inches

ThA0 Tyre loamy sand and sandy loam, 0 to 2 percent slopes.
ThB1 Tyre loamy sand and sandy loam, 2 to 6 percent slopes, slightly eroded.
ThC1 Tyre loamy sand and sandy loam, 6 to 12 percent slopes, slightly eroded.

The total acreage in this county is small. The soils are used for crops and pasture, but yields are low because of droughtiness. Rotations suggested for the soils of soil management unit 4bA(IIIW) can be used on these soils. Because of the small acreage, information on estimated yields is not available for these soils.

Soil management group 4c

This soil management group consists of (1) level to gently sloping, dark-colored soils that developed from loamy sand to sandy loam parent materials under poor drainage and (2) poorly drained soils that developed on stratified sands and gravel and have a sandy loam to sandy clay loam subsoil, 2 to 20 inches thick.

These soils have a high natural supply of organic matter, but at times they are damaged by deposits of coarse-textured, less fertile material that are washed in from adjacent upland slopes.

If they are adequately drained, the soils in this group are suited to all field crops grown in the county. Yields are not so high as those on the soils in management group 3c. Areas that cannot be adequately drained are largely used for permanent pasture and second-growth forest. Trees are seldom planted.

Maintaining adequate drainage and fertility are the principal problems of management on this soil management group. Where outlets are available, these soils can be drained by tile lines.

Applications of lime are seldom needed. Where these dark-colored soils are acid, they need 50 percent more lime than is recommended in table 5. These neutral to calcareous soils generally have deficiencies in manganese and boron. Some crops will need additions of these elements in fertilizers.

Use the minimum amount of tillage that will control weeds, provide a suitable seedbed, and maintain the plow layer in a condition that permits water to penetrate and seedlings to emerge. Fertilizer ratios, grades, and rates of application should be selected on the basis of the crop to be grown, the kind of soil, and the result of soil tests (see table 14).

SOIL MANAGEMENT UNIT 4cA(IIIW)

Nearly level, dark-colored, coarse to moderately coarse textured soils formed under poor drainage

EcA0 Edmore and Ensley sandy loams, 0 to 2 percent slopes.
EeA0 Epoufette and Ronald sandy loams, 0 to 2 percent slopes.

If adequately drained, these soils are suited to all field crops grown in the county. Yields are moderate under improved management. New plantings of trees on wet sites are not recommended. The existing woodlots provide fair to moderate yields of woodland products.

Adequate drainage is the main management need if these soils are cropped. These soils can be drained by

open ditches or by tile lines spaced 6 to 8 rods apart. It is difficult, however, to maintain the proper grade of the tile lines in many places because sand occurs at depths where the tile should be laid. To keep the tile lines from filling with sand, they should be covered with topsoil, straw, or similar materials. It may be necessary to delay ditching and tiling until the dry period of the year.

A suggested rotation consists of 2 years of a legume-grass, 1 year of a row crop, 1 year of a small grain, and 1 year of a small grain seeded to legume-grass (85). Other suggested rotations are listed in table 4. Any rotation in that table having value of relative protectiveness greater than (85) also can be used on this soil management unit.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ---------- bushels --	40	70
Beans ---------- bushels --	15	22
Sugar beets ---------- tons --	8	13
Wheat ---------- bushels --	23	38
Oats ---------- bushels --	35	65
Barley ---------- bushels --	28	42
Alfalfa ---------- tons --	1. 8	3. 3
Mixed hay ---------- tons --	1. 4	2. 2

SOIL MANAGEMENT UNIT 4cB(IIIW)

Gently sloping, slightly eroded, dark-colored, coarse to moderately coarse textured soils formed under poor drainage

EcB1 Edmore and Ensley sandy loams, 2 to 6 percent slopes, slightly eroded.

EeB1 Epoufette and Ronald sandy loams, 2 to 6 percent slopes, slightly eroded.

If adequately drained, these soils are suited to all field crops grown in the county, including forage crops. Yields are moderate under good management. New tree plantings on wet sites are not suggested. The existing woodlots produce fair to moderate yields of woodland products.

Adequate drainage is the main management need if these soils are cropped. These soils can be drained by open ditches or by tile lines spaced 6 to 8 rods apart. It is difficult, however, to maintain the proper grade of the tile lines in many places because sand occurs at depths where the tile should be laid. To keep the tile lines from filling with sand, they should be covered with topsoil, straw, or similar materials. It may be necessary to delay ditching and tiling until the dry period of the year. Care will also be needed to maintain proper grade of the tile lines in these gently sloping areas.

A suggested rotation consists of 2 years of a legume-grass, 1 year of a row crop, 1 year of a small grain, and 1 year of a small grain seeded to legume-grass (85). Any rotation that has a value of relative protectiveness (see table 4) greater than (85) also can be used.

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn ---------- bushels --	40	70
Beans ---------- bushels --	15	22
Sugar beets ---------- tons --	8	13
Wheat ---------- bushels --	23	38
Oats ---------- bushels --	35	65
Barley ---------- bushels --	28	42
Alfalfa ---------- tons --	1. 8	3. 3
Mixed hay ---------- tons --	1. 4	2. 2

Soil management group 5a

This soil management group consists of (1) well to moderately well drained, light-colored, very droughty sands and (2) sands with loam to clay materials at depths of 42 to 66 inches.

The management units within this group have different slope ranges, which are designated by capital letters that follow the group symbol. In group 5a, the capital letters and the slopes they stand for are:

A---------- 0 to 2 percent slopes (nearly level).
B---------- 2 to 7 or 2 to 8 percent slopes (gently sloping).
C---------- 7 to 14 percent slopes (moderately sloping).
D---------- 8 to 18 or 14+ percent slopes (strongly sloping).

In this soil management group, the soils that have been used the same way on the steeper and longer slopes are generally more eroded than on the less sloping areas and need a more protective cropping system.

The soils in this management group have a low content of plant nutrients and organic matter, low moisture-holding capacity, and high susceptibility to erosion, especially wind erosion. Consequently, these soils are among the least productive in the county for field crops.

The level and gently sloping areas are best suited to deep-rooted crops, winter grains, and short-season crops. Where the soils in the group have been irrigated and managed intensively, special crops have been grown successfully. Legumes and grasses are grown in areas that are properly fertilized and seeded. To reduce wind erosion in cultivated fields, alternate strips of forage crops and small grain or row crops are frequently planted. Many of the steep or eroded sites are planted to trees. Red pine, Scotch pine, and jack pine are used for reforestation.

The main deficiencies of the soils in this group can be partly overcome by using a cropping system that builds up plant nutrients through additions of fertilizer and organic matter. In many places, however, a positive soil-building program is needed because these soils have been poorly managed. The program outlined for the soils in management group 4a can be used on these sandy soils.

The soils in this group should be covered as much of the time as possible because of serious erosion hazard if they are left bare for even a short time. Till just enough to control weeds and make an adequate seedbed. Use a field cultivator, particularly on sloping areas, when preparing areas for reseeding to legume-grasses. To help reduce erosion, leave crop residues on the surface.

In table 15, crop rotations are suggested for each soil management unit in soil group 5a. These rotations are the least protective that can be recommended for safe use under the practices of erosion control named in table 15. The rotations listed in table 4 that have a value of relative protectiveness less than those in table 15 do not adequately protect the soils if they are cultivated under the practices named. Rotations with a greater value adequately protect the soils. Minimum tillage, the removal of crop residues, and other practices may affect the amount of protection needed. The protection needed decreases with a decrease in slope and as other erosion control practices are used.

These soils generally need lime. Soil tests to determine the lime requirement should be made, preferably before the soils are broken for a new crop or for a reseeding.

Fertilizer ratios, grades, and rates of application should

TABLE 15.—*Suggested crop rotations that give the least amount of protection that can be safely used, under named practices of water-erosion control, for the soil management units in group 5a*

Soil management unit	Slope	Erosion	Practices of water-erosion control			
			None	Contour tillage	Stripcropping	Terracing
	Percent					
5aA(IVS)	0–2	Slight	AARW [1](87)[2]	Not used	Not used	Not used.
5aB(IVS)	2–7 2–8	Slight	AARW(87)	AARW(87)	AARW(87)	AARW(87).
5aC(IVS)	7–14	Slight	AAARW(90)	AARW(87)	AARW(87)	AARW(87).
5aD(VIIS)	8–18 14+	Slight and moderate	Permanent vegetation (grass or trees).			

[1] Rotation symbols: A, legume-grass; R, row crop; W, winter grain. These symbols are the same as those in table 4. Rotations are recommended on the assumption that all crop residues, at least 2 tons per acre, are returned to the soil and plowed under immediately before planting.

[2] Number in parentheses refers to the relative protectiveness of the cropping system. A cropping system that has a value of relative protectiveness greater than the one given for a particular soil management unit and erosion control practice may be used (see table 4).

be selected according to the crop to be grown, the kind of soil, and the result of soil tests. In table 16, for named crops, are suggested ratios, grades, and rates of application of fertilizer for the soils in groups 5a, 5b, and 5c. All soils should be tested before fertilizers and lime are applied.

SOIL MANAGEMENT UNIT 5aA(IVS)

Nearly level, slightly eroded, light-colored, well to moderately well drained, very droughty sands

CgA1 Croswell loamy sand, 0 to 2 percent slopes, slightly eroded.
KaA1 Kalkaska and Wallace fine sands, 0 to 2 percent slopes, slightly eroded.
MhA1 Melita and Arenac loamy sands, 0 to 2 percent slopes, slightly eroded.

These very droughty soils are low in natural fertility and in moisture-holding capacity. They are susceptible to wind erosion where they are not covered with vegetation.

These soils have a limited use for field crops. Yields of intertilled crops are low. Because they are very droughty in summer, these soils are not well suited to pasture. Early in spring and late in fall, however, they provide good pasture. Deep-rooted legumes and grasses that can withstand drought should be planted for pasture. Yields of these forage crops are low. These soils are well suited to new plantings of red, jack, and white pines. The white pine should be planted in the low, moist, less exposed areas. Yields from woodlots are low.

If these soils are used for row crops, the crops should be grown in rotations and protected against wind. A suggested rotation consists of 2 years of a legume-grass, 1 year of a row crop, and 1 year of a winter grain seeded to a legume-grass (87). Any other rotation that has a value of relative protectiveness greater than (87) (see table 4) also can be used. Return all crop residues to the soil, use green-manure and cover crops, and supply lime and fertilizer in amounts indicated by soil tests (see tables 5 and 16).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn .... bushels	15	40
Wheat .... bushels	11	22
Oats .... bushels	17	33
Alfalfa .... tons	.9	2.3
Mixed hay .... tons	.6	1.4

SOIL MANAGEMENT UNIT 5aB(IVS)

Gently sloping, slightly eroded, light-colored, well to moderately well drained, very droughty sands

CgB1 Croswell loamy sand, 2 to 7 percent slopes, slightly eroded.
KaB1 Kalkaska and Wallace fine sands, 2 to 8 percent slopes, slightly eroded.
MhB1 Melita and Arenac loamy sands, 2 to 7 percent slopes, slightly eroded.

These soils are low in natural fertility and are highly susceptible to wind erosion.

They are not well suited to intertilled crops and are only fairly well suited to legumes and grasses. Pasture has low animal carrying capacity during the dry summer. These soils are fairly well suited to trees. For new plantings use red pine, jack pine, and a limited number of white pines on the better protected, moist sites.

If these soils are used for intertilled crops, plant the crops in strips and keep half the field in forage crops. Use no more than one row crop every 4 years (87). Any rotation that has a value of relative protectiveness greater than (87) (table 4) also can be used on the soils in this unit. If these soils are used for pasture, plant deep-rooted legumes that are drought resistant.

Return all crop residues and grow green-manure crops. Apply lime and fertilizer in amounts indicated by soil tests (see tables 5 and 16).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	Prevailing management	Improved management
Corn .... bushels	15	40
Wheat .... bushels	11	22
Oats .... bushels	17	33
Alfalfa .... tons	.9	2.3
Mixed hay .... tons	.6	1.4

TABLE 16.—*Recommended fertilization for*

[N stands for nitrogen, P_2O_5 for

Crops	If the soil tests—						
	Low in phosphorus and low in potassium—				Low in phosphorus and high in potassium—		
	Apply per acre—			At rate and grade of [1]—	Apply per acre—		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*
Alfalfa,[2] alfalfa-brome,[2] clover, and sweetclover	0	45	90	300 lb. of 0-15-30	0	45	45
Alfalfa after each harvest year [2]	0	30	90	300 lb. of 0-10-30	0	30	30
Grass without a legume	30	30	30	300 lb. of 10-10-10	30	30	0
Barley [3 4] or oats [3 4] without legume seeding	16	32	32	200 lb. of 8-16-16	16	32	16
Field beans [3 4] and soybeans [3 4]	10	20	40	200 lb. of 5-10-20	10	20	20
Wheat [3 4] or rye [4] without legume seeding	12	50	50	250 lb. of 5-20-20	12	50	25
Corn [4]	10	40	40	200 lb. of 5-20-20	10	40	20

[1] Rates and grades are examples of recommended fertilization. Other rates and grades can be used to obtain the suggested amounts of nitrogen, phosphoric acid, and potash.
[2] Apply fertilizer containing ½ percent boron if pH is more than 6.5.
[3] Where pH is above 6.5, apply fertilizer containing 1 or 2 percent manganese.
[4] Supplemental nitrogen may be needed.

SOIL MANAGEMENT UNIT 5aC(IVS)

Moderately sloping, slightly eroded, light-colored, well-drained, very droughty sand

MkC1 Melita loamy sand, 7 to 14 percent slopes, slightly eroded.

This soil is very droughty and is low in natural fertility. It is slightly eroded by wind and water and when cropped is highly susceptible to further erosion.

This soil is not well suited to row crops and is only fairly well suited to trees and to pasture. Deep-rooted grasses and legumes that are drought resistant are suitable for pasture. For new plantings of trees use red pine and jack pine along with a limited number of white pines on the moister sites.

If this soil is used for intertilled crops, they should be grown in strips on the contour and in a rotation that provides a legume-grass at least half of the time (87). Do not plant a row crop more than once in 4 years (see table 15). Other rotations are suggested in table 4. Any rotation in that table that has a value of relative protectiveness greater than the one given for a specific practice in table 15 also can be used.

Return all crop residues and grow green-manure crops and cover crops whenever possible. Apply lime and fertilizer in amounts indicated by soil tests (see tables 5 and 16).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop		*Prevailing management*	*Improved management*
Corn	bushels	10	35
Wheat	bushels	10	20
Oats	bushels	15	30
Alfalfa	tons	.9	2.3
Mixed hay	tons	.6	1.4

SOIL MANAGEMENT UNIT 5aD(VIIS)

Strongly sloping to steep, slightly to severely eroded, light-colored, well-drained, very droughty sands

KaC1 Kalkaska and Wallace fine sands, 8 to 18 percent slopes, slightly eroded.
MkD2 Melita loamy sand, 14+ percent slopes, slightly to severely eroded.

These soils are very low in fertility and very low in moisture-holding capacity. They are extremely droughty and, in exposed areas, are highly susceptible to wind and water erosion.

These soils are unsuited to crops or pasture because of unfavorable slopes, and native trees grow very slowly. They are, however, best suited to trees and to use for wildlife habitats. For new plantings of trees, use jack pine or red pine. Planting is difficult on the steeper slopes, and the trees should be planted on the contour to prevent them from being washed out during rainstorms.

Soil management group 5b

This soil management group consists of imperfectly drained soils that were developed from deep sand parent materials and sands with loam to clay materials at depths of 42 to 66 inches.

These soils have low natural fertility and have a high water table. In their natural state, they are poorly suited to most field crops. They may be made productive in many places, however, by adding fertilizers and lime and by seeding ladino clover, alsike clover, Dutch white clover, bromegrass, and other suitable legumes and grasses. In many places, additions of fertilizers and lime will cause the growth of desirable legumes or grasses. Because of the high water table, these soils often furnish productive pasture during the summer when the pasture in drier areas is poor.

soil management groups 5a, 5b, and 5c.

phosphoric acid, and K_2O for potash]

If the soil tests—Continued								
Low in phosphorus and high in potassium—Continued	High in phosphorus and low in potassium—				High in phosphorus and high in potassium—			
At rate and grade of [1]—	Apply per acre— N	Apply per acre— P_2O_5	Apply per acre— K_2O	At rate and grade of [1]—	Apply per acre— N	Apply per acre— P_2O_5	Apply per acre— K_2O	At rate and grade of [1]—
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	
225 lb. of 0-20-20	0	30	90	300 lb. of 0-10-30	0	22	45	150 lb. of 0-15-30.
150 lb. of 0-20-20	0	30	90	300 lb. of 0-10-30	0	15	45	150 lb. of 0-10-30.
90 lb. of 33-0-0 + 150 lb. of 0-20-0.	30	0	30	90 lb. of 33-0-0 + 30 lb. of 0-0-60.	30	0	0	90 lb of 33-0-0.
160 lb. of 10-20-10	8	16	32	160 lb. of 5-10-20	16	16	16	160 lb. of 10-10-10.
125 lb. of 8-16-16	4	13	40	150 lb. of 3-9-27	5	10	20	100 lb. of 5-10-20.
250 lb. of 5-20-10	12	25	50	250 lb. of 5-10-20	12.5	25	25	150 lb. of 8-16-16.
200 lb. of 5-20-10	10	20	40	200 lb. of 5-10-20	10	20	20	125 lb. of 8-16-16.

These sandy soils are susceptible to wind erosion where they are drained and cropped. Open ditches do not hold their shape. The sides continually slough or cave in, thus making tile drains difficult to install. Even where it is possible to install tile drains, a great deal of care must be taken in covering the tile, or the sand will clog the tile.

Tillage should be the minimum that will control weeds, provide an adequate seedbed, and maintain the surface soil in a condition that permits water to penetrate and seedlings to emerge.

Fertilizer ratios, grades, and rates of application should be selected on the basis of the crop to be grown, the kind of soil, and the results of soil tests. In table 16, for named crops, are suggested ratios, grades, and rates of application of fertilizer for the soils in this group. All soils should be tested before fertilizers and lime are applied.

SOIL MANAGEMENT UNIT 5bA(IVW)

Nearly level to gently sloping, moderately dark colored sands developed under imperfect drainage

AeA0 Au Gres and Saugatuck loamy sands, 0 to 2 percent slopes.

AeB1 Au Gres and Saugatuck loamy sands, 2 to 6 percent slopes, slightly eroded.

These soils are low in natural fertility and are medium to extremely acid. They have low moisture-holding capacity and generally are too dry for good plant growth during a part of the growing season.

These soils are not well suited to field crops, but they produce fair pasture in areas where the water table is not too high and lime and fertilizer are applied. Trees are seldom planted on these soils, and yields from existing woodlands are low.

Artificial drainage is needed before crops can be grown. Open ditches are generally used in most areas. These ditches, however, need careful maintenance because they fill with sand that blows in or that caves in from the ditch banks.

If crops are grown, they should be planted in strips to reduce wind erosion. Rotations that provide legume-grass at least half of the time are suggested. One such rotation consists of 2 years of legume-grass, a row crop, and then a winter grain (87). Another suitable rotation is 3 years of legume-grass, a row crop, a spring grain, and then a winter grain (88). Other suggested rotations are given in table 4. Any rotation that has a value of relative protectiveness greater than (87) also can be used on this soil management unit.

Return all crop residues to the soil and apply lime and fertilizer in amounts indicated by soil tests (see tables 5 and 16).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	*Prevailing management*	*Improved management*
Corn bushels	17	45
Wheat bushels	12	24
Oats bushels	18	36
Alfalfa tons	1.0	2.5
Mixed hay tons	.7	1.6

Soil management group 5c

This soil management group consists of poorly drained soils that were formed from deep sand parent materials and sands with loam to clay materials at depths of 42 to 66 inches.

These soils contain a very small amount of plant nutrients and have a high water table. In their natural state, they are poorly suited to most crops. They may be made productive in many places, however, by adding fertilizer and lime and by seeding ladino clover, alsike clover,

Dutch white clover, bromegrass, bluegrass, and other suitable legumes and grasses. In many places, additions of fertilizer will cause the growth of desirable legumes and grasses without a seeding. Because of the high water table, these soils furnish productive forage during July and August when upland pasture is poor.

The principal soil management problems are improving drainage, increasing fertility, and controlling wind erosion. Open ditches are generally used for drainage. Tile is difficult to install because the trenches in which the tile is laid continually cave in. The tile lines must be carefully covered to prevent sand from filtering in. Pasture needs to be fertilized so that desirable legumes and grasses can be maintained.

Tillage should be the minimum that will control weeds, provide an adequate seedbed, and maintain the surface soil in a condition that permits water to penetrate and seedlings to emerge.

Lime is seldom needed on these soils. Where these dark-colored soils are acid, they need 50 percent more lime than that recommended in table 5. Fertilizer ratios, grades, and rates of application should be selected on the basis of the crop to be grown, the kind of soil, and the results of soil tests. In table 16, for named crops, are recommended pounds per acre, with examples of grades and rates of application, for the soils in this group. All soils should be tested before fertilizer and lime are applied. Manganese and boron fertilizer may be needed for some crops.

SOIL MANAGEMENT UNIT 5cA(IVW)

Nearly level, dark-colored sands formed under poor drainage

RcA0 Roscommon loamy sand, 0 to 2 percent slopes.
RdA0 Roscommon mucky loamy sand, 0 to 2 percent slopes.
TeA0 Tobico mucky loamy sand, 0 to 2 percent slopes.

These soils are low in natural fertility and are generally too dry for plant growth during a part of most growing seasons.

These soils are not very well suited to field crops, but they produce fair pasture in areas where the water table is not too high and lime and fertilizer are applied. Trees are seldom planted on these soils; yields of woodland products are low.

These soils need to be drained before crops can be grown, but even then yields are low. Open ditches are generally used for drainage. These ditches, however, need careful maintenance because they fill with sand that blows in or that caves in from the ditchbanks. If tile is used for drainage, the lines should be spaced 6 to 8 rods apart at depths of 36 to 48 inches.

If crops are grown, they should be planted in strips so that the hazard of wind erosion is lessened. Rotations that provide legume-grass at least half of the time are suggested (87). Other rotations are given in table 4. Any rotation in that table having a value of relative protectiveness greater than (87) can be used on this soil management unit. Return all crop residues and apply fertilizer in amounts indicated by soil tests (table 16).

Expected yields per acre of important crops under prevailing management and improved management are:

Crop	*Prevailing management*	*Improved management*
Corn ... bushels	20	50
Wheat ... bushels	13	26
Oats ... bushels	20	40
Alfalfa ... tons	1.2	2.7
Mixed hay ... tons	.8	1.7

Soil management group 5.3a

This soil management group consists of well drained to imperfectly drained, light-colored, extremely droughty sands and sands with loam to clay materials at depths of 42 to 66 inches. The imperfectly drained soils are of very limited acreage and are closely associated with the well-drained soils.

Because they are extremely droughty, low in plant nutrients, and susceptible to erosion when cultivated, the soils in this group have little agricultural value. They may, however, be used for hay or pasture where they are associated with finer textured cultivated soils. Their best use is for trees and for recreation.

If trees are planted for timber or Christmas trees, use either seedlings or transplants. Jack pine and red pine are generally planted on these soils. Extension Bulletin 264 published by the Cooperative Extension Service of Michigan State University (*13*) gives more information on planting trees.

SOIL MANAGEMENT UNIT 5.3aA(VIIS)

Nearly level to gently sloping, slightly eroded, light-colored, well to imperfectly drained, extremely droughty sands

EaA1 Eastport, Arenac, and Kalkaska sands, 0 to 2 percent slopes, slightly eroded.
EaB1 Eastport, Arenac, and Kalkaska sands, 2 to 7 percent slopes, slightly eroded.
EbA0 Eastport fine sand and Beach sand, 0 to 2 percent slopes.
ReA1 Rubicon sand, 0 to 2 percent slopes, slightly eroded.
ReB1 Rubicon sand, 2 to 7 percent slopes, slightly eroded.

These soils are very low in fertility and in water-holding capacity. They are highly susceptible to wind erosion where they are exposed. For these reasons, these soils are generally not used for field crops or pasture, and small areas that are cropped produce very low yields. Most of the acreage that was once cropped is now idle or has been reforested. These soils should be kept in trees. They make good wildlife habitats. Native trees grow slowly. Jack pine and red pine are best for new plantings.

SOIL MANAGEMENT UNIT 5.3aC(VIIS)

Gently sloping to steep, slightly to severely eroded, light-colored, well-drained, extremely droughty sands

EaC1 Eastport, Arenac, and Kalkaska sands, 7 to 14 percent slopes, slightly eroded.
EbC0 Eastport fine sand and Beach sand, 2 to 18 percent slopes.
ReB3 Rubicon sand, 2 to 7 percent slopes, moderately or severely eroded.
ReC1 Rubicon sand, 7 to 14 percent slopes, slightly eroded.
ReC2 Rubicon sand, 7 to 14 percent slopes, moderately or severely eroded.
ReD1 Rubicon sand, 14+, percent slopes, slightly eroded.
ReD3 Rubicon sand, 14+ percent slopes, moderately or severely eroded.

In addition to being gently sloping to steep and slightly to severely eroded, these soils are very low in natural fertility and very low in moisture-holding capacity. They are not recommended for crops or pasture and are

best suited to forestry or to use as wildlife habitats. Planting of trees is difficult on the strongly sloping to steep areas. The trees should be planted on the contour, or at least across slope, so that the trees will not wash out during rainstorms.

Soil management groups L2c, L3b, and L3c

These groups consist of alluvial soils that developed from stratified moderately coarse to moderately fine textured materials under moderately good to poor drainage. Most of the soils developed under imperfect and poor drainage. They are likely to be flooded by adjoining streams.

Pasture and woodland are the best uses for the soils in this group. Where the flooding hazard has been reduced by the straightening and deepening of the streams, cultivated crops are grown in fields that are large enough for efficient farm operations. In many places, row crops are grown continuously. White clover, ladino clover, alsike clover, and other moisture-tolerant legumes are suggested for pasture.

Flooding, inadequate drainage, and early frosts are the principal hazards for these soils. Flooding is likely in the spring and in other seasons after periods of heavy rainfall. Pasture should be fertilized to increase plant growth and to maintain desired species. Suggested rates and grades of fertilization for named crops are given in tables 10 and 12. Because of flooding and frost hazards, crop yields are variable.

SOIL MANAGEMENT UNIT L2c(IIIW)

Nearly level to gently sloping, dark-colored, moderately coarse to moderately fine textured alluvial soils developed under poor drainage

WaA0 Wallkill loam, 0 to 2 percent slopes.
WcA0 Washtenaw loam and silt loam, 0 to 2 percent slopes.
WcB0 Washtenaw loam and silt loam, 2 to 6 percent slopes.
WdA0 Washtenaw sandy loam and loam, 0 to 2 percent slopes.
WdB0 Washtenaw sandy loam and loam, 2 to 6 percent slopes.

These soils are flooded at times by runoff from adjacent sloping fields. The small areas are ordinarily managed the same way as the adjacent upland soils. Because of flooding and frost hazards, crop yields are variable. The larger areas are used for pasture.

Flooding, inadequate drainage, and early frosts are the principal hazards on these soils. Flooding is likely in spring and in other seasons after periods of heavy rainfall. Pasture should be fertilized to increase plant growth and maintain desired species. Suggested rates and grades for fertilization are given in table 10.

SOIL MANAGEMENT UNIT L3b(IIIW)

Level to gently sloping, moderately dark colored, imperfectly to moderately well drained sandy loam alluvial soils

AcA0 Alluvial land, imperfectly or moderately well drained sandy loams, 0 to 2 percent slopes.
AcB0 Alluvial land, imperfectly or moderately well drained sandy loams, 2 to 6 percent slopes.

Row crops can be grown continuously on areas of sufficient acreage that have been adequately drained and protected from flooding. Yields are good to excellent. Other areas are best suited to pasture and woodland. Forage crops have high yields if suitable legumes or grasses are seeded. The kinds of legumes and grasses vary with the degree of drainage and flooding. Suggested rates and grades for fertilization are given in table 12. The second-growth forest has not been managed for the purpose of producing woodland products. Trees are not planted on these soils.

SOIL MANAGEMENT UNIT L3c(VW)

Level to gently sloping, dark-colored, moderately coarse to medium textured alluvial soils developed under poor drainage

AbA0 Alluvial land, poorly drained loams, 0 to 2 percent slopes.
AbB0 Alluvial land, poorly drained loams, 2 to 6 percent slopes.
AdA0 Alluvial land, poorly drained sandy loams, 0 to 2 percent slopes.
AdB0 Alluvial land, poorly drained sandy loams, 2 to 6 percent slopes.
KbA0 Kerston muck, 0 to 2 percent slopes.

These poorly drained soils occur in irregularly shaped areas that are generally difficult to reach with farm equipment. They occur along streams that flood regularly. Almost all the acreage is in permanent pasture or second-growth forest. If adequately fertilized, these soils produce good pasture. The second-growth forest has not been managed for the purpose of producing woodland products.

Soil management groups M/1c, M/mc, M/3c, M/4c, Mc-a, and Mc

Organic soils are generally called mucks or peats. The mucks have decomposed to such an extent that the original plant materials cannot be recognized. The peats consist largely of undecomposed or only slightly decomposed organic materials.

Organic soils are placed in management units according to (1) reaction (pH); (2) natural vegetative cover; (3) thickness of the deposits; (4) kind of organic materials; and (5) if the organic deposits are shallow, the texture of the underlying mineral materials.

In the following pages, some of these characteristics of organic soils are discussed as well as other subjects that are important to the management of organic soils.

Soil reaction (pH).—Most of the organic soils in Sanilac County are well supplied with lime. Lime is not needed if the pH is above 5.0. In some places, the pH of the surface layers varies considerably from that of the underlying materials. The amount of lime needed for very acid organic soils depends on the pH and on the depth to which the acidity extends. If the pH is between 4.6 and 5.0, applications of 2 to 3 tons of limestone per acre are needed. If the pH is between 3.8 and 4.2, 8 to 12 tons of limestone per acre may be required. The limestone must be mixed into the soil to a depth of 12 to 15 inches.

Manganese, which is an essential plant nutrient for many crops, is often unavailable to plants if the pH of the soil is more than 6.0. Soils that have a pH above 6.5 need additions of sulfur at the rate of 500 to 1,000 pounds per acre to correct the high fixing power of these soils for manganese. If alkaline soils are to be farmed, and sulfur is used, apply 10 to 20 pounds of actual manganese per acre at planting time. In addition, spray the foliage several times, at intervals of 7 to 10 days, with water-

soluble manganese sulfate at a rate of 3 to 8 pounds per acre. It is not advisable to attempt to increase the acidity of organic soils that contain a considerable amount of free lime or marl. Such soils should not be planted to onions, spinach, soybeans, lettuce, or wheat.

Drainage.—Organic soils were formed after woody and fibrous materials accumulated in poorly drained old lake basins or drainageways. These soils must be properly drained before they can be cultivated. In most places a system of open ditches and tile lines is used. The proper distance between the lateral tile lines or the open ditches depends on the texture and the permeability of the underlying mineral materials. When the drains or open ditches are not deep enough to provide an adequate flow by gravity, the installation of a pumping system should be considered.

Tile at least 5 inches in diameter should be used. If the pH of the soil is less than 6.0, clay tile is preferred. On recently developed areas, the tile should be placed at a depth greater than it is placed in old areas. This is because recently cleared and drained areas settle considerably within a few years after reclamation.

The control of the water level should be planned before any drainage system is installed. Soils that consist largely of peat absorb a considerable amount of water and should be thoroughly drained at the start of drainage operations. After organic soils are cropped several years, crevices and channels are formed that accelerate the movement of water. Soils also hold less water after their organic matter is decomposed. The water table should be kept at a depth of about 30 inches below the surface by using water from deep wells, drainage ditches, and springs in the fields.

Poorly drained fields or fields that are likely to be flooded should be kept in trees or pasture or should be used for forage crops.

Cabbage, carrots, and soybeans are suited to fairly well drained organic soils. Crops that need well-drained but not droughty soils are mint, potatoes, head lettuce, and corn.

Clearing the soils.—In the reclamation of organic soils, the cost of clearing must be considered. This cost may be so high that it is not profitable to clear the soils. Grasses, sedges, or small brush can be cleared fairly easily. Fields covered with tamarack, spruce, and other conifers that are resistant to decay are expensive to clear and cultivate. Areas should be avoided where fallen trees and roots are buried and are laid one upon another. Installing tile is very expensive in these woody sites.

Frost hazard.—Crops growing on organic soils are generally more likely to be damaged by frost than those on adjacent upland mineral soils. Before selecting crops for an area, consider the likelihood of frost and the susceptibility of the crops to frost. Grasses, celery, carrots, and cabbage are fairly resistant to frost. Moderately resistant are spinach, sugar beets, head lettuce, small grains, and onions. Sudangrass, potatoes, mint, and corn are quite susceptible to frost; beans, pumpkins, melons, and tomatoes are very susceptible. Crops growing on dry, loose soils are particularly susceptible to frost, for such soils conduct heat slowly to the air. Cool, clear, calm nights induce frost in summer.

To help prevent damage to crops by frost:

(1) Maintain a compact soil surface.
(2) Maintain a high content of water in the soil by keeping a high water table or by sprinkler irrigation.
(3) Improve the air drainage of the field.
(4) Add liberal amounts of potash to the soil.
(5) Use minimum tillage; apply herbicides to control weeds.

Wind erosion.—Wind erosion may destroy crops, carry away fertilizer, spread soil-borne diseases and weeds, fill ditches and fence rows, and shorten the life of shallow organic soils. Wind erosion is most severe when the soil is loose and dry. Some organic soils have a granular structure and are naturally loose and finely divided. Others become finely divided as the result of cropping for a number of years. The fiber content and cohesiveness of a soil indicate its susceptibility to erosion.

To help reduce wind erosion:

(1) Grow windbreaks, especially along ditches and fence lines. Species suggested for such plantings are white pine, Austrian pine, or green willow. Spirea and multiflora rose are also suitable, but they lack height.
(2) Grow grain in strips. Winter rye can be planted at intervals of about 60 feet. The rye can be harvested for grain, or the strips where it is grown can be used for roadways, or both.
(3) Grow two crops in alternate strips so that one is a buffer strip. Each strip should be 75 to 100 feet wide. Grasses are good buffer strips.
(4) Use interplanted grain, such as spring wheat, barley, or rye, which is planted in rows 2 or 3 feet apart. Interplanted grain must be cut off just below the surface of the soil when the crop it has protected is large enough to protect itself. Interplanted rye may be established in fall ahead of regular seeding.
(5) Wet the surface soil by keeping the water table high or by irrigation.
(6) Increase the amount of raw organic fiber in the soil by plowing deep and bringing some of the peat to the surface or by plowing under a green-manure crop.
(7) Keep the surface rough. Some of the equipment used on the Great Plains can be used on many areas of muck in Sanilac County. Wide-spaced rows can be cultivated with an ordinary surface cultivator that has all but one shovel removed from each gang. This shovel is V-shaped and is set to plow deep between rows. Minimum tillage and wheel-track planting are suggested for corn production.

Conservation.—Before organic soils are reclaimed, a careful study should be made to determine (1) if there will be a demand for the crops to be grown; (2) if the soil is suitable for these crops; and (3) if the soil can be adequately drained. It is better to keep organic soils in their natural state than to manage them poorly.

When an area of organic soil is drained, the surface of the land is lowered because of soil compaction upon drying. The destruction of organic matter results from chem-

ical or biological oxidation, from fire, and from wind erosion. Excessive oxidation may be reduced by installing a system to control the water level. This system should keep the water table just low enough to be satisfactory for the growth of crops.

Muck soils should not be burned. If fires are accidentally started on muck, the areas should be encircled with deep ditches and flooded. If the fire is not very intense, it can be smothered by disking.

Soil fertility.—Organic soils are naturally low in fertility but are highly productive when the required elements are added. Potassium generally is needed most, and fertilizers such as 0-10-30, 5-10-20, and 3-9-27 are commonly used. Phosphorus is needed in moderate amounts, especially by the soils high in lime (pH greater than 6.7). Nitrogen fertilizers are needed for crops grown on cool, poorly drained, acid soils. Crops in other places also need nitrogen after periods of heavy rainfall. Copper is needed for most crops grown on raw, deep organic soils that have a pH less than 6.5. For further information on the fertilization of organic soils see Cooperative Extension Bulletin 159, published by the Michigan State University (*11*).

Hay and pasture.—A large part of the cleared muck in Sanilac County is in hay and pasture, but most of these areas are so poorly managed that the forage crops furnish little nourishment to livestock. Poorly drained muck is suited to reed canarygrass, and better drained muck is suited to bromegrass, timothy, clover, alsike clover, and ladino clover. Oats, sudangrass, and fall-sown rye can be used as emergency pasture. A fertilizer high in potash that contains the required minor elements should be used on pastures. Additional information on management of hay and pasture can be obtained in Cooperative Extension Bulletin 304, published by the Michigan State University (*7*).

SOIL MANAGEMENT UNIT M/1c(IIIW)

Level, dark-colored, very poorly drained organic soil with fine-textured mineral materials at depths of 12 to 42 inches

WeA0 Willette muck, 0 to 2 percent slopes.

The underlying fine-textured mineral materials are slowly permeable.

If it is adequately drained, this soil is suited to crops and pasture. Reed canarygrass can be grown on areas that are not artificially drained. In other areas, the quality and quantity of the pasture depend on the drainage, the kinds of legumes or grasses, and the fertilization program. This soil is not planted to trees. Trees grow slowly in woodlands and produce poor yields. Elm, ash, and red maple are the main species on this soil.

SOIL MANAGEMENT UNIT M/mc(IVW)

Level, dark-colored, very poorly drained organic soils less than 42 inches deep over marl

EdA0 Edwards muck, 0 to 2 percent slopes.
WbA0 Warners muck and Marl, 0 to 2 percent slopes.

These soils are neutral to moderately alkaline. Plowing turns up marl in some places. The underlying marl makes drainage difficult.

The deeper areas of these soils are used for vegetables and other row crops, which can be grown continuously. Care must be used in the selection of the truck crops. The areas with marl at a shallow depth should be left in permanent pasture and trees. Yields of forage crops are satisfactory in areas that are adequately drained and fertilized. Yields of woodland products are low.

Wind erosion should be controlled on these soils. Large amounts of fertilizer with a high content of potash are needed for high yields (*11*).

SOIL MANAGEMENT UNIT M/3c(IIW)

Level, dark-colored, very poorly drained organic soils with coarse- to medium-textured mineral materials at depths of 12 to 42 inches

LdA0 Linwood muck, 0 to 2 percent slopes.
LeA0 Linwood and Tawas mucks, 0 to 2 percent slopes.
PaA0 Palms muck, 0 to 2 percent slopes.
PbA0 Palms and Adrian mucks, 0 to 2 percent slopes.

Wind erosion on these soils may be severe, and crops may be damaged by frost.

If adequately drained, these soils are suited to crops and pasture. They are particularly well adapted to truck crops, but the risk of damage by frost is greater than on the adjacent upland soils. The quality and quantity of the pasture depend on the degree of drainage, the kinds of legumes and grasses, and the fertilization program. Reed canarygrass or other water-loving legumes or grasses can be grown on the undrained areas. These soils are poorly suited to trees, but wooded areas furnish some posts and firewood. Trees are not planted on these soils.

These soils can be drained by tile or open ditches or by a combination of these. Tile drainage, however, is hazardous. The organic soils do not provide a suitable foundation for the tile lines. In most instances, however, the tile is laid in mineral soils that furnish a satisfactory foundation. Wind erosion can be reduced by keeping the water table high or by planting windbreaks. Apply fertilizer in amounts that soil tests indicate the specific crops require (*11*).

SOIL MANAGEMENT UNIT M/4c(IVW)

Level, dark-colored, very poorly drained organic soils with coarse-textured materials at depths of 12 to 42 inches

AaA0 Adrian muck, 0 to 2 percent slopes.
TcA0 Tawas muck, 0 to 2 percent slopes.

If adequately drained, these soils are suited to crops and pasture, but trees are not planted. Pastures are good when properly fertilized.

Controlling the height of the water table is necessary. In designing the drainage system, the rapid permeability of the underlying coarse-textured materials must be considered. Only ditches are used in some places. Crop yields are moderate to low in overdrained areas. Because the organic materials are shallow, the control of wind erosion is important. Cover crops should be grown whenever possible.

SOIL MANAGEMENT UNIT Mc-a(VIIIW)

Level, very poorly drained, deep, raw, acid peats

GdA0 Greenwood peat, 0 to 2 percent slopes.
ScA0 Spalding peat, 0 to 2 percent slopes.

These soils support little vegetation and are not suited to crops, pasture, or trees. They are covered with leatherleaf and sphagnum moss and should be used for wildlife

habitats and recreational purposes. These soils are a potential source of commercial acid peat.

SOIL MANAGEMENT UNIT Mc(IIIW)

Level, very poorly drained, deep organic soils, well to moderately well supplied with bases

CcA0 Carlisle muck, 0 to 2 percent slopes.
CdA0 Carlisle and Linwood mucks, 0 to 2 percent slopes.
HaA0 Houghton muck, 0 to 2 percent slopes.
HbA0 Houghton and Palms mucks, 0 to 2 percent slopes.
RbA0 Rifle peat, 0 to 2 percent slopes.

These soils are highly susceptible to wind erosion, and crops on them may be damaged by frost.

If adequately drained these soils are suited to crops and pasture. They are particularly well suited to truck crops, but the risk of damage by frost is greater than on the adjacent upland soils. Intertilled crops can be grown continuously. The quantity and quality of the pasture depend on the degree of drainage, the kinds of legumes and grasses, and the fertilization program. Reed canarygrass and other water-loving grasses can be grown on areas that are not artificially drained. Although these soils are poorly suited to trees, some posts and some firewood are harvested from woodlands. Trees, however, are not planted.

These soils can be drained by tile or open ditches or by a combination of these. Tile drainage, however, is hazardous because these organic soils do not provide a suitable foundation for the tile lines. Wind erosion can be reduced by keeping the water table high and by planting windbreaks. Apply fertilizer in amounts that soil tests indicate the crops to be grown will need (*11*).

Miscellaneous land types S(VIIIS)

The following miscellaneous land types are not suitable for agriculture, pasture, or forestry:

Ce Clay pit.
Gc Gravel pit.
La Lake beach, sandy.
Lb Lake beach, rocky.
Lc Lake beach, stony.
Md Made land.

Engineering Applications[8]

This soil survey report contains information that can be used by engineers. This engineering section (1) outlines common engineering uses of the soil information and refers to more comprehensive publications that interpret soil information so that it can be used more readily by engineers; (2) points out sections of the report that are particularly useful to engineers; and (3) lists engineering laboratory data for soil samples collected from 12 soil profiles in Sanilac County.

Engineering Uses of Soil Information

In the following list of engineering uses, the publications designated by italicized numbers give information on the engineering operations listed. The publications are listed in Literature Cited. The information in this report is useful for—

1. Making reconnaissance surveys of soils for the purpose of planning the location of highways or airports and for planning more detailed engineering soil surveys at these locations (*10*).
2. Relating soil features, by use of the soil map, to other land features and to cultural features.
3. Locating sand, gravel, and clay for construction purposes (*10*).
4. Correlating pavement performance with the kinds of soil so that an economical and effective design for foundations and pavements can be made (*10*).
5. Determining the suitability of soils for cross-country movements of vehicles and construction equipment under various conditions of soil and climate (*10*).
6. Supplementing information from other published maps and reports so that engineering soil maps and reports can be made.
7. Selecting and developing industrial, business, residential, and recreational sites.
8. Estimating runoff and erosion so that effective structures for soil and water conservation can be made (*14*).
9. Designing drainage systems.
10. Designing irrigation systems.
11. Establishing plants to stabilize or beautify an area.

The soil survey map and the soil descriptions in this report do not provide sufficient detailed information for many engineering uses. Within each area delineated on the map, there may be small areas of soils other than the one described. These inclusions generally are not described in detail. Consequently, the map should be used only in planning for a more detailed study of the soils and their condition, in place, at the site of each proposed structure.

Sections of Report Useful to Engineers

Engineers who are not familiar with the procedure used in making the soil surveys, or with the terms used by the agricultural soil scientist, should refer to the sections, How to Use the Soil Survey Report, Descriptions of Soils, and the Glossary. Attention is called particularly to the following terms in the Glossary: *soil, clay, silt, sand, aggregate, and granular*. The term "soil" may be particularly confusing. Agriculturists think of soil as a natural body made up of different horizons that have somewhat different characteristics. Engineers, most likely, will single out each horizon as a different kind of soil or refer to the unconsolidated materials at the earth's surface, including sediments such as glacial drift, as soil. The Field Manual of Soil Engineering published by the Michigan State Highway Department (*10*) gives information on soils that is useful to an engineer. The section, Morphology and Genesis of Soils and tables 1 and 2 should be helpful, for here the relationships of the soils in Sanilac County are described. This information should be helpful to the engineer when he is making his own measurements and observations.

[8] O. L. STOKSTAD and A. E. MATTHEWS, Michigan State Highway Department, and P. C. SMITH, Bureau of Public Roads, assisted in preparing this section.

Engineering Test Data

Samples from 12 soil profiles were collected by soil scientists during the course of this survey. These samples were tested in the soils laboratory of the United States Bureau of Public Roads in accordance with standard procedure (*2*) to help evaluate the soils for engineering purposes. The test data are given in table 17. This table lists the data obtained in mechanical analyses, plasticity tests, and moisture-density tests. It also gives the two commonly used engineering classifications for each sample.

Samples were tested from the principal horizons of four medium-textured soil series—Guelph, McBride, Marlette, and Parkhill. Samples were also tested from the principal horizons of three finer textured series—Huron, Jeddo, and Perth. Although the Guelph samples were taken from four locations and both the Marlette and Parkhill samples were taken from two locations, the test data probably do not represent the maximum range in physical characteristics of these soil series. Some of these soils were not sampled to a depth greater than 3 feet, and the greatest sampling depth was 78 inches. Hence, the samples are not representative of the materials that may be encountered at greater depths.

Table 1, page 2, shows the relationship of the soils tested to other mineral soils in Sanilac County.

Morphology and Genesis of Soils

This section has two main parts. In the first part, the factors that have affected the development of soils in Sanilac county are discussed. In the second part, the soil series in the county are listed in their respective great soil groups and the great soil groups are described.

Factors of Soil Formation

The soils of Sanilac County differ from each other because five groups of factors have influenced their formation. These groups of factors are: (1) time, or age; (2) climate; (3) vegetation; (4) parent material; and (5) topography and drainage.

Sanilac County and the region around it were overridden four times by continental ice sheets called glaciers (*8*). The ice sheets advanced during cold cycles and retreated during warmer interglacial periods. Probably, interglacial periods were much longer than periods when the area was covered by ice (*5*)

Time, or age of soil

After the last ice sheets (glaciers) melted, the processes of soil development started to change the glacial debris. Most of the glacial material was high in lime and contained the other common mineral elements of plant nutrition except nitrogen. Since glaciation, part of the water from annual rainfall and snowfall has been moving down through the soil. The water, containing dissolved oxygen, carbon dioxide, and other soluble materials, has caused changes in the original mineral deposits. Materials such as free lime have been leached out, and some of the minerals have been reduced to smaller clay particles, which have been washed down into lower horizons. As a result of these changes, horizons differing in physical and chemical composition have gradually developed.

Time is needed for the development of the soil profile characteristics that result from the soil-forming factors other than time. These characteristics are most clearly expressed in the profiles of the older soils in the county. The youngest soils in the county are on the more recently deposited alluvial sediments. Because they have not been in place long enough to allow distinct horizons to form, these soils have characteristics that are largely the same as those of the deposited materials. These very young soils are the Alluvial soils in the county.

Immature soil profiles are also found in small, recent accumulations of eroded material or colluvium that have been deposited in basins and drainageways below cultivated fields. Accelerated erosion has created a large number of these small, recent deposits on which the processes of soil formation have not yet had much effect.

The influence of time is also shown in a study of the older soils of Sanilac County by Allen and Whiteside (*1*). They found that the depth to which carbonates have been leached, although somewhat variable throughout the county, was usually greater in soils developed in parent materials of Cary age than in those developed in younger materials of Mankato age. The mean depth of leaching in comparable soil profiles that developed from calcareous materials of loam texture was found to be 29 inches in the Cary till but only 20 inches in Mankato till. It was also found that the mean carbonate content of deep, unaltered samples of Cary till was 22.9 percent, whereas that of similar samples of Mankato till was 31.4 percent. Allen and Whiteside pointed out that this difference in carbonate content could account for a considerable part of the difference in depth of leaching. On the basis of difference in leaching depth, carbonate content, and permeability, they estimated that the Cary till in Sanilac County could be between 1,100 and 5,500 years older than the Mankato till. It was also observed that a double profile—a sequence of A_2, B_{h-ir}, A_2, and B_t horizons—was developed in the well-drained soils in Cary till and was more pronounced than the double profile developed in soils in Mankato till.

Mick (*12*) has reported that there is greater depth of leaching in soils in Sanilac County outside the Port Huron moraine (Cary age) than inside that moraine (Mankato age).

Climate

Climate is an important factor in soil formation. Soils developing in the dry climate of western Kansas for example, or in the warm, humid climate of Alabama, differ markedly from the soils of Sanilac County. In Sanilac County, the soils have formed under a cool, moist climate that is somewhat influenced by the proximity of Lake Huron. The mean annual precipitation in Sanilac County is about 31 inches. Although it is generally uniform in all seasons, it is somewhat less in winter than in summer. The winters are fairly long and cold, and the summers are fairly short and mild. Because it is normally uniform throughout the county, climate is not a cause of major differences between the various kinds of soils. The cli-

TABLE 17.—*Engineering test data* [1] *for soil samples*

Soil type and location	Parent material	Bureau of Public Roads report number	Depth	Horizon	Mechanical analyses [2]			
					Percentage passing sieve			
					1½-in.	1-in.	¾-in.	⅜-in.
			Inches					
Guelph loam: SE¼SE¼ sec. 6, T. 13 N., R. 15 E.	Loam till	89942	0–10½	A_p			100	99
		89943	10½–17	B_{2t}				
		89944	17+	C_2		100	99	98
Guelph loam: NW¼SW¼ sec. 13, T. 13 N., R. 15 E.	Loam till	89963	0–7	A_p			100	99
		89964	7–14	B_{2t}			100	98
		89965	14+	C_2		100	98	97
Guelph loam and silt loam: NE¼NW¼ sec. 21, T. 9 N., R. 16 E.	Loam till	89957	0–8	A_p		100	96	95
		89958	8–19	B_{2t}		100	99	99
		89959	23+	C_2			100	99
Guelph loam and silt loam: SW¼SW¼SW¼ sec. 2, T. 14 N., R. 14 E.	Loam till	91719	0–5	$A+B_h$			100	98
		91720	5–9	A_2			100	98
		91721	9–18	B_{2t}				
		91722	26–30	C_2				100
Huron silt loam: NW¼NE¼ sec. 30, T. 14 N., R. 13 E.	Silty clay loam till	89945	0–14	A				
		89946	14–30	B_{2t}		100	99	99
		89947	30+	C		100	99	99
Jeddo silty clay loam: SW¼NW¼SW¼ sec. 31, T 9 N., R. 16 E.	Silty clay loam till	91723	0–6½	A_p				
		91724	6½–11	GA				
		91725	11–26	GB				
		91726	26–54	GC				
		91727	60+	C				100
McBride fine sandy loam: SW¼NE¼ sec. 14, T. 14 N., R 13 E.	Sandy loam till	89951	4–10	A_2+B_h		100	99	97
		89952	16–46	B_{2t}		100	97	96
		89953	46–78	C_1		100	97	97
Marlette loam: SW¼NE¼ sec 30, T. 11 N., R 12 E.	Loam till	89948	3–6	A_2			100	99
		89949	15–30	B_{2t}				100
		89950	30+	C				100
Marlette loam: SW¼NW¼ sec. 18, T. 9 N., R. 13 E.	Loam till	89960	8–24	A_2+B_h		100	97	95
		89961	24–40	B_{2t}				100
		89962	40+	C	100	97	96	94
Parkhill loam: SE¼SW¼SW¼ sec. 20, T. 12 N., R. 15 E.	Loam till	91733	0–7	A_p				
		91734	7–16	GA				
		91735	16–23	GB_1				
		91736	23–30	GB_2				
		91737	30–36	GB_3				
		91738	36+	C				
Parkhill loam: NW¼SW¼SW¼ sec. 6, T. 11 N., R. 15 E.	Loam till	91728	0–7½	A_p				
		91729	7½–17	GA				
		91730	17–29	GB_2				
		91731	29–46	GB_3				
		91732	56+	C			100	97
Perth silt loam: NW¼NW¼ sec. 15, T. 14 N., R. 14 E.	Silty clay loam till	89954	0–5	A_p			100	99
		89955	7–14	B_{2tg}				
		89956	15+	C				

[1] Tests performed by Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials (AASHO). Standard Specifications for Highway Materials and Methods for Sampling and Testing, Part 2, 7th Edition, 1955 (*2*).

[2] Mechanical analyses according to the American Association of State Highway Officials Designation: T 88 (*2*). Results by this procedure frequently differ somewhat from results that would have been obtained by the pipette method commonly used by the Soil Conservation Service. In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material,

taken from 12 soil profiles, Sanilac County, Mich.

Mechanical analyses [2]—Continued									Liquid limit	Plasticity index	Maximum dry density	Optimum moisture	Engineering classification	
Percentage passing sieve—Con.					Percentage smaller than—									
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.					AASHO [3]	Unified [4]
											Lb. per cu. ft.	*Percent*		
98	97	92	85	70	64	48	28	18	25	6	110	15	A-4(7)	ML-CL.
100	99	96	90	76	73	62	42	35	37	19	111	17	A-6(12)	CL.
97	96	92	88	78	75	60	38	29	30	14	122	13	A-6(10)	CL.
98	97	92	82	63	58	44	25	16	29	8	109	16	A-4(6)	ML-CL.
97	96	90	81	59	55	41	26	19	25	10	122	12	A-4(5)	CL.
95	93	88	81	64	60	48	32	23	27	12	121	13	A-6(7)	CL.
95	94	89	81	64	59	47	26	16	31	7	104	17	A-4(6)	ML-CL.
99	99	98	96	89	87	77	54	42	39	18	109	17	A-6(11)	CL.
98	97	94	91	82	81	72	44	30	29	12	120	14	A-6(9)	CL.
97	95	86	75	57	51	39	23	15	25	6	114	14	A-4(4)	ML-CL.
97	96	90	82	66	60	48	29	20	20	5	120	12	A-4(6)	ML-CL.
------	100	96	92	79	75	63	46	38	36	18	111	17	A-6(11)	CL.
99	98	93	88	75	72	58	34	24	28	13	120	13	A-6(9)	CL.
------	100	97	92	78	72	52	27	17	44	11	94	23	A-7-6(9)	ML.
99	98	95	93	84	81	70	48	36	36	16	112	17	A-6(10)	CL.
99	98	95	94	89	88	80	59	41	39	17	112	17	A-6(11)	CL.
------	100	97	91	75	72	62	42	29	45	16	94	23	A-7-6(11)	ML.
------	100	97	92	76	71	59	39	28	36	15	107	18	A-6(10)	CL.
------	100	97	92	74	70	58	40	29	34	15	113	15	A-6(10)	CL.
------	100	96	91	74	71	61	41	30	36	17	113	15	A-6(11)	CL.
99	98	94	91	80	76	66	45	30	33	13	114	16	A-6(9)	CL.
94	90	83	68	45	37	22	12	6	NP[5]	NP[5]	113	13	A-4(2)	SM.
94	91	82	71	41	36	24	15	11	17	3	125	11	A-4(1)	SM.
97	96	92	85	49	38	21	10	7	NP[5]	NP[5]	118	11	A-4(3)	SM.
98	96	89	78	49	41	26	14	9	21	3	115	13	A-4(3)	SM.
99	98	94	88	70	67	54	40	30	31	13	115	16	A-6(8)	CL.
99	97	92	84	63	59	48	33	24	28	12	121	13	A-6(6)	CL.
94	92	84	74	46	42	29	18	14	16	3	124	10	A-4(2)	SM.
99	98	93	86	68	66	57	37	29	29	13	118	13	A-6(8)	CL.
93	92	86	80	61	55	39	21	15	20	6	126	10	A-4(5)	ML-CL.
------	------	100	88	58	53	43	30	20	38	12	98	20	A-6(5)	ML-CL.
------	100	99	85	50	48	41	29	21	24	10	123	11	A-4(3)	CL.
------	------	100	85	54	52	44	30	24	26	12	122	12	A-6(5)	CL.
------	100	99	84	52	48	40	29	23	25	13	123	12	A-6(4)	CL.
------	------	100	88	57	54	45	29	22	23	10	122	12	A-4(4)	CL.
------	------	100	92	67	64	52	31	21	23	9	122	12	A-4(6)	CL.
------	100	97	93	69	60	44	27	20	44	10	91	23	A-5(8)	ML.
------	100	97	93	69	62	46	29	22	29	10	114	15	A-4(7)	CL.
------	100	97	93	69	62	47	31	24	30	11	114	14	A-6(7)	CL.
------	100	96	92	69	61	45	28	21	26	9	117	14	A-4(7)	CL.
93	88	87	82	59	52	38	24	15	22	6	124	11	A-4(5)	ML-CL.
98	97	94	89	76	75	63	38	25	41	13	100	22	A-7-6(9)	ML.
------	100	99	97	88	87	81	55	41	40	18	110	17	A-6(11)	CL.
------	100	99	98	95	94	88	55	38	37	16	112	18	A-6(10)	CL.

including that coarser than 2 millimeters in diameter. In the pipette method, the various grain-size fractions are calculated on the basis of the material finer than 2 millimeters in diameter. The mechanical analyses reported in this table are therefore not suitable for use in naming the textural classes given in the Soil Survey Manual (*15*).

[3] The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO. Designation: M 145-49 (*2*).

[4] The Unified Soil Classification System, Technical Memorandum No. 3-357, Volume 1, Waterways Experiment Station, March 1953 (*16*).

[5] Nonplastic.

mate of Sanilac County is discussed in more detail in the section, General Nature of the Area.

Vegetation

The original vegetation has influenced the formation of soils in the county. Except for small areas of grasslands and marshes, the land was largely covered with forest when the pioneers arrived in Sanilac County. The characteristics of the soils that developed were affected by the native vegetation, and the vegetation, in turn, influenced the development of the soil profile. Directly related to the nature of the vegetative cover are the physical and chemical characteristics of the organic surface horizons. The forest cover also influenced the thickness and color of the bleached mineral soil horizon that is directly beneath the organic accumulations. The vegetation of the county is described in the section, General Nature of the Area.

Parent material

The influence of parent material in the formation of soils has been one of the most important factors in determining present differences among the soils of Sanilac County. Bedrock is exposed at the surface in only a few places, and the overlying mantle of glacial debris is the parent material of all mineral soils on uplands in the county. The characteristics of the glacial material, however, vary considerably from place to place. Materials deposited originally as ground moraines, outwash plains, lake-bottom sediments, or sand dunes differed markedly in such features as lime content, permeability, and the size distribution of particles. Many of these distinctions are reflected in differences among the soils that have developed from the various kinds of materials. The relationships of parent material and of natural drainage to the mineral soils of Sanilac County are shown in table 1, p. 2.

Topography and drainage

The influence of topography in soil formation is related primarily to the natural drainage conditions that are associated with differences in topographic position. The height of water table, quantity of soil water, degree of soil aeration, and other factors related to natural drainage have a pronounced effect upon the kinds of soil profiles that develop. The relationship of natural drainage to mineral soils formed from different kinds of parent material is shown in table 1, p. 2. Characteristics of the Bog (organic) soils, which have formed under very poorly drained conditions, are shown in table 2, p. 3.

Great Soil Groups

The soil series of Sanilac County have been placed in seven great soil groups according to the similarities of the major features of their soil profiles. The soils in each great soil group have the same number and kinds of definitive horizons. They vary somewhat, however, in the degree of expression of such horizons and in soil color, soil texture, thickness of soil profile, and other properties.

In the list that follows, the soil series in Sanilac County are placed in their respective great soil groups.

1. Podzols
   - Arenac
   - Au Gres
   - Croswell
   - Eastport
   - Iosco
   - Kalkaska
   - *Melita
   - Menominee
   - Rubicon
   - Tyre
   - Wallace
2. Podzols (intergrading to Gray Wooded soils)
   - Capac
   - Coral
   - Gagetown
   - *Gladwin
   - Guelph
   - London
   - McBride
   - McGregor
   - Mancelona
   - Marlette
   - Montcalm
   - *Newaygo
   - Otisco
   - *Palo
   - Richter
   - Sanilac
   - *Saverine
   - *Winegars
3. Ground-Water Podzols
   - Saugatuck
4. Gray Wooded soils
   - Huron
   - Perth
5. Humic Gley soils
   - Bach
   - Edmore
   - Ensley
   - Epoufette
   - Jeddo
   - Parkhill
   - *Ronald
   - Roscommon
   - Tappan
   - Thomas
   - Tobico
   - Tonkey
   - Warners
6. Bog (organic) soils
   - Adrian
   - Carlisle
   - Edwards
   - Greenwood
   - Houghton
   - Linwood
   - Palms
   - Rifle
   - Spalding
   - Tawas
   - Willette
7. Alluvial soils
   - Kerston
   - Wallkill
   - Washtenaw

In the foregoing list, the following soil series, indicated by an asterisk, are tentative: Gladwin, Melita, Newaygo, Palo, Ronald, Saverine, and Winegars.

1. *Podzols* have developed on well-drained or imperfectly drained sands. They are characterized by an eluviated, leached, ash-gray A_2 horizon underlying a very thin, dark-colored, organic-mineral A_1 horizon and leaf litter. The B horizon consists of an accumulation of brown to reddish-brown iron oxides and humus that has been concentrated by movement from the overlying horizons. Although the practical significance of this kind of a subsoil has not yet been completely evaluated, it is known that iron oxides react with phosphates to form insoluble compounds.

2. *Podzols* (*intergrading to Gray Wooded soils*) were developed from loamy sand to loam materials on well-drained and imperfectly drained sites. They have a soil profile with upper horizons similar to those described for Podzols developed on well-drained or imperfectly drained sands, but the characteristic Podzol sequence of A_2 and B_t horizons is underlain by another sequence of eluviated (washed-out) A_2 and illuviated (washed-in) B_t horizons. The B_t horizon is enriched by silicate clay that has been washed down from the overlying horizons, formed in place, or inherited from materials similar to the underlying glacial materials. Consequently, the B_t horizons are finer textured than either the overlying or underlying horizons in the soil profile.

Gardner and Whiteside (*6*) studied these kinds of profiles that were developed from parent materials of different texture. They found that the upper Podzol horizons are more strongly expressed on coarse-textured materials, and that the fine-textured subsoil (B_t) horizons are best developed on the more calcareous and argillaceous materials. They referred to this arrangement and sequence of soil horizons as a double profile. They concluded that all

horizons in the double profile are genetic and are the result of either the simultaneous development of all horizons or the succession of a younger Podzol profile in the A_2 horizon of an older, thicker soil.

Gardner and Whiteside concluded that these double profiles represent the zonal soils for this area and are correlatives of similar soils in New York and Ontario. These soils are neither true Podzols nor true Gray Wooded soils, but they exhibit some characteristics of both groups. The degree of affinity to one or the other group is related to the texture of the parent material. These soils are, therefore, classified as Podzols (intergrading to Gray Wooded soils).

Cann (*3*) studied the genesis of one of these double profiles. He concluded that the profile may be regarded as genetic. Evidence was found that indicated the two eluviation processes occurred at the same time. Cann concluded that in addition to eluviation from the surface horizons and deposition of humus and sesquioxides in the upper B horizon, there is an eluviation of clay and its deposition in the B_t horizon lower in the profile. This conclusion supports the contention of Gardner and Whiteside that simultaneous processes involving the movement of different constituents and their deposition in different parts of the solum may occur in these soils.

3. *Ground-Water Podzols* have developed in deep, very sandy materials where the water table fluctuates within 2 to 4 feet of the surface. These soils resemble Podzols in many respects, but they differ in that A_2 horizons are thicker and nearly white in color, and the upper B horizons are thicker and very strongly cemented in a form called ortstein. Ground-Water Podzols are of very limited extent in Sanilac County and are represented by only the Saugatuck series.

4. *Gray Wooded soils*, in this county, were developed on well-drained and imperfectly drained sites from moderately fine textured parent materials. These soils have only the clayey subsoil B_t horizons and lack the upper horizon sequence characteristic of the Podzols. They occur in the cooler parts of Michigan associated with the Podzol soils. In kind and sequence of horizons, Gray Wooded soils are similar to the Gray-Brown Pozolic soils of southern Michigan. They generally have whiter A_2 horizons than the Gray-Brown Podzolic soils. Apparently the A_2 horizon infiltrates into the B_t horizon. In places, remnants of the B_t horizon may be found in the lower part of the A_2 horizon. These soils are of limited extent in Sanilac County. The only soil series in this group are the Huron and Perth.

5. *Humic Gley soils* are poorly to very poorly drained mineral soils that were formed in low-lying areas where water did not cover the soil completely enough for organic soils to develop. These soils support a swamp-forest type of vegetation. Organic matter has been better preserved and mixed with the mineral soils to a greater depth than in their well-drained, timbered associates. The organic-mineral surface horizons are darker colored and thicker than those of the associated better drained Podzols and Gray Wooded soils. Under this organic-mineral horizon, the poorly drained soils are frequently solid gray in color or have an olive-gray layer that, in most places, is splotched or streaked with orange, rust brown, or yellow. The formation of these dull gray, solid gray, or olive colored gleyed horizons (G) is associated with the reduction of iron in the presence of organic matter under conditions of poor or very poor drainage and aeration. Where the gray colors are less prevalent, their presence is indicated by a small "g" in addition to a capital letter for that horizon.

Where they were developed from the same kind of parent material as the well-drained Podzols or Gray Wooded soils, the poorly drained soils in Sanilac County are less acid and generally contain more nitrogen than their better drained associates. Poorly drained soils that were developed from calcareous parent materials generally are neutral to moderately alkaline throughout the soil profile.

6. *Bog* (*organic*) *soils* are poorly or very poorly drained soils that have more than 12 inches of organic materials in the form of either muck or of peat over mineral materials. Nearly all of the organic deposits are in old marshes and lakebed areas. In a few places, the peats are 40 to 50 feet deep. Highly decomposed organic soils are classified as mucks; raw or slightly decomposed organic soils in which the plant structures can still be identified are called peats.

The organic materials, which may be woody or fibrous, were preserved because water prevented their rapid oxidation. Anaerobic processes, however, cause some decomposition, even in submerged materials. The degree of decomposition is related both to the nature of the vegetative material and to the height of the water table.

Sphagnum moss and leatherleaf plants have frequently contributed to extremely acid, organic accumulations that show very little or no decomposition. The original plant materials are recognizable at the surface. This condition is characteristic of the Greenwood and Spalding soils.

The relationships between the various kinds of organic soils in Sanilac County are shown in table 2, p. 3.

7. *Alluvial soils* have characteristics that are largely the same as those of the deposited materials. These materials have not been in place long enough for the processes of soil formation to develop distinct horizons. Differences in natural drainage, however, are indicated by the color of the soils and the amount of organic matter that the surface layer contains. In places layers of alluvium alternate with layers of muck that may be either transported or accumulated in place. Most of the areas of alluvial soils are susceptible to periodic flooding.

General Nature of the Area

This section is prepared for those who are not familiar with the county. It contains information on physiography, climate, vegetation, and other subjects of general interest.

Physiography

The surface features of Sanilac County, for the most part, result from the effects of the Wisconsin, or latest, glacial period (*5*, *8*). Under the younger Wisconsin drift, along the shore of Lake Huron and along the Black River, are dense glacial deposits that are thought to be older than the Wisconsin drift. The thickness of these deposits varies from a thin layer to more than 250 feet. Except for

areas near Tyre, where the Marshall sandstone is at a shallow depth, bedrock did not directly influence the development of the soils in the county.

The strongly developed, rolling Port Huron moraine in the eastern part of the county marks the limits of a distinct readvance of the ice mass, whereas the more undulating moraines in the south-central and southwestern parts of the county were caused by temporary halts of the retreating glaciers. The Port Huron moraine rises some 30 to 40 feet above the old lake plain to the west, and its maximum elevation is about 180 feet above the present level of Lake Huron.

Climate

The climate of Sanilac County is favorable for the growth of most farm crops cultivated in Michigan. Summer is mild and pleasant and has only a few extremely hot days. Winter is moderately long and cold. Temperatures as high as 103° F. and as low as —23° have been recorded, but these extremes are rare. The average annual temperature is 47°. Table 18, compiled from the records of the United States Weather Bureau Station, gives temperature and precipitation data from Sandusky in Sanilac County. These figures are representative of conditions that prevail over a large part of the county.

The seasons change gradually, with an average difference in temperature of 19.8° between winter and spring, 24.7° between spring and summer, 18.1° between summer and fall, and 26.4° between fall and winter. The temperature fluctuates more in spring than in any other season. Spring is somewhat colder than fall, which approaches gradually and is the most pleasant season of the year. Summer has an average temperature of 68.8°, but occasional hot spells may be oppressive because of high humidity.

The average frost-free period of 131 days at Sandusky extends from May 22 to September 30. This is long enough for most crops to mature. Killing frosts, however, have been recorded as late as June 20 and as early as September 13. The frost-free period varies considerably with elevation, air drainage, and distance from Lake Huron.

A strip of land 3 to 5 miles wide along Lake Huron is protected by an upland moraine on the west. In this area the growing season is longer than in the rest of the county. The frost-free period near Lake Huron averages about 140 days.

The average annual precipitation is 31.31 inches and is distributed fairly evenly throughout the year. Although the average yearly snowfall at Sandusky is 41.6 inches, the snow seldom accumulates to a depth of more than 1 foot. This snow cover gives some protection to fall-sown grain. The snow cover, however, is seldom continuous, and occasionally grain is killed in winter. Mild blizzards frequently occur during cold spells.

Rainfall varies considerably in summer, and soils in the county that receive the same amount of precipitation have marked differences in moisture-holding capacity. Nevertheless, crops seldom fail because they lack moisture. The crops on sandy soils, however, may be damaged because of a moisture deficiency in the hottest part of the summer or during periods of drought. Precipitation in summer is frequently in the form of thundershowers. Some hail may fall, but it is seldon so severe that it seriously damages crops.

TABLE 18.—*Temperature and precipitation at Sandusky Station, Sanilac County, Michigan*

[Elevation, 774 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1914)	Wettest year (1926)	Average snowfall
	°F.	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	26.4	61	−21	2.27	1.03	2.36	9.4
January	22.8	63	−18	1.63	1.97	3.27	10.6
February	23.7	60	−23	1.48	.71	2.95	9.7
Winter	24.3	63	−23	5.38	3.71	8.58	29.7
March	32.8	82	−13	1.95	.68	3.69	6.8
April	44.4	90	−1	2.44	1.08	3.26	1.4
May	55.1	96	17	4.30	2.06	2.14	.3
Spring	44.1	96	−13	8.69	3.82	9.09	8.5
June	66.7	99	30	3.59	1.32	3.29	(3)
July	70.0	103	36	3.42	4.16	1.17	(3)
August	69.6	101	32	2.76	4.19	6.97	(3)
Summer	68.8	103	30	9.77	9.67	11.43	(3)
September	62.0	98	27	2.78	.70	3.91	(3)
October	52.3	86	15	2.58	1.78	3.59	.1
November	37.9	80	0	2.11	.27	3.32	3.3
Fall	50.7	98	0	7.47	2.75	10.82	3.4
Year	47.0	103	−23	31.31	19.95	39.92	41.6

[1] Average temperature based on a 37-year record, through 1955; highest and lowest temperatures on a 30-year record, through 1952.
[2] Average precipitation based on a 37-year record, through 1955; wettest and driest years based on a 27-year record, in the period 1910–1955; snowfall based on a 32-year record, through 1952.
[3] None.

Prevailing winds are westerly and are seldom strong enough to damage crops. Wind erosion is a serious problem on mucks and loose, incoherent sands in exposed positions. Occasionally, tornadoes have severely damaged buildings and crops in small areas.

Vegetation

When the white man first settled in Sanilac County, the entire area, except for a small acreage of marshland, was covered by forest. The better drained, medium- to fine-textured soils supported a growth of sugar maple, beech, basswood, and oak and a few scattered pines and hemlocks. The proportion of white pine and mixed hardwoods was higher on the well drained to imperfectly drained, coarse-textured soils. Dense stands of elm, ash, white oak, silver maple, and red maple grew on the poorly drained sites. These wet areas were locally called "elm flats."

The native vegetation on the timbered organic soils consisted largely of aspen, red maple, willow, elm, tamarack,

and black spruce and red-oiser dogwood, alder, and other shrubs. The wet marshes contained wiregrass and bluejoint, and in the bogs were leatherleaf, blueberry, hypnum moss, and sphagnum moss.

In the 1870's and 1880's, Sanilac County was swept by devastating forest fires, which destroyed a considerable part of its forest resources. The second growth is largely aspen. Imported Lombardy poplar has become widely distributed over the county, especially on the lake plains along Lake Huron. Second-growth white birch and white cedar are also plentiful in the lake shore area.

Early Settlement, Development, and Population

The first permanent white settlers, who were mostly Canadians of English or Irish descent, came to Sanilac County between 1840 and 1850. These settlers were seeking religious freedom. They were primarily interested in agriculture, instead of exploitation of timber and mineral resources. The clearing of land was slow, laborious, and costly, and the size of the farms was small. Crops were grown mainly for home use.

Later the timber resources were exploited, and this exploitation caused a critical period in the history of the county. By 1880, a large part of the timber in the county had been cut. Most of the swampy areas were in the hands of speculators who did not live on their land. These nonresident owners, however, developed the first drainage systems in the county in order to profit from their extensive holdings. Drainage operations probably could not have been carried out for many years by individual farmers because they lacked the necessary capital. After the drainage systems were established, population increased rapidly and farming became more and more commercialized.

By 1880, the population of Sanilac County was 26,341. Population continued to increase until 1900, when the U.S. Census reported 35,055 people living in the county. After 1900, the population gradually declined; but it has increased slightly between 1930 and 1950. The U.S. Census reported 27,751 people in 1930; 30,114 in 1940; and 30,837 in 1950.

Sandusky, Croswell, and Marlette are the largest towns, but none of these towns had a population as large as 2,000 in 1950. Smaller communities are Brown City, Minden City, Deckerville, Lexington, Port Sanilac, Carsonville, and Applegate.

All the population in the county is classed as rural. The people are well distributed throughout the county. The slight differences in density of population are directly related to the productivity of the soils.

Transportation

Except for the communities along the Lake Huron shore, most towns and villages in Sanilac County are served by the Chesapeake and Ohio Railroad.

U.S. Highway 25 and State Highways 19, 51, and 53 pass through the county in a north-south direction. Adequate east and west transportation is provided by State Highway 46 and improved hard-surfaced county roads. A complete network of improved gravel and hard-surfaced county roads provides all-weather outlets for practically all rural residents. Detroit is the chief market for agricultural products. It is easily accessible by bus, truck, and private automobile.

Agriculture

More people are engaged in agriculture in Sanilac County than in any other enterprise, and the products of agriculture have greater value than those of any other enterprise. A large quantity of farm products is consumed within the county, but considerable quantities of foodstuffs—mainly dairy products, vegetables, and poultry products—are exported to the large cities in Michigan. Detroit is the principal market.

The history of agriculture in Sanilac County parallels the history of the county itself. A semipermanent agriculture was overthrown when the warring Chippewas defeated the Sak Indians. The Chippewas, in turn, were driven westward during the early decades of the nineteenth century by white settlers. These early settlers grew crops mainly for home use. Their chief cash income came from the sale of furs and shingles, which were often used as a medium of exchange.

The entire area had been surveyed by 1840. A quarter of a century later, most of the pine and hardwood forest had been completely exploited by the lumber barons. During this period, most settlers earned at least a part of their income working in lumber camps and at sawmills.

After the trees in the county had been removed, most of the upland areas were divided into small farms. These farms were the basis for a fair agricultural economy. The chief settlements were along the lake shore and on the adjacent uplands. Most of the interior was considered of little or no agricultural value because it consisted of low-lying elm flats, undrained tamarack swamps, and huckleberry marshes. These areas were poorly drained, but they were acquired by speculators who had enough capital to construct many miles of open ditches. Drainage made the soils productive.

After the soils were drained, settlers who came from Pennsylvania, Ohio, and eastern States started to farm them. A few Polish and German immigrants settled in the county. The elm flats were cleared by felling and burning the big trees. During this period, potash and wood ashes were important exports. The cleared land was well suited to general farming in which hay and forage crops were important.

The influx of settlers was rapid and steady until the early 1900's, when population started to decline. This decline was related to industrial expansion and the resulting growth of cities. The agriculture of the area near cities was affected by the demand created for vegetables, poultry products, and dairy products. Because of the demand in Detroit for whole milk and other dairy products, dairy farming has become one of the chief enterprises in Sanilac County.

Size, Number, and Type of Farms

Since 1920, the total acreage of land in farms in Sanilac County has changed very little. In 1920, 549,849 acres

were in farms; and in 1954, the total was 551,370 acres. Between 1940 and 1954, however, the size and number of farms varied considerably. The census of agriculture reports a 16 percent decrease between 1940 and 1954 in number of farms; but, in this period, the average-size farm has increased from 113.3 acres to 133.7 acres.

In 1954, the farms of Sanilac County were grouped by type as follows:

Type of farms	Number
Field crops other than vegetable and fruit and nut	891
Cash grain	841
Other field crops	50
Vegetable	10
Fruit and nut	15
Dairy	1,832
Poultry	80
Livestock other than dairy and poultry	177
General	426
Primarily crop	80
Primarily livestock	45
Crop and livestock	301
Miscellaneous and unclassified	694

Crops

According to the 1954 Census of Agriculture, the principal crops grown in Sanilac County, in order of decreasing acreage, were oats, alfalfa hay, wheat, corn, timothy, clover, and mixtures of clover and grasses cut for hay, and field beans (table 19). Thus, most of the cultivated land was planted to crops that were used to feed livestock. In addition to these crops, more than 5,000 acres of red clover and alfalfa were harvested for seed, and more than 5,000 acres of sugar beets were harvested for sugar production.

Livestock

Dairying is the most important livestock enterprise in Sanilac County. According to the 1954 Census of Agriculture, there were about 38,523 dairy cows in the county and about 241,542,545 pounds of whole milk sold in 1954. Large amounts of butter were made for home use and for sale.

Table 20 gives the number of livestock on farms in Sanilac County at stated intervals since 1930. The number of cattle has increased since 1930, but the number of horses and mules has decreased. This decrease in horses and mules is a result of farm mechanization and more efficient farming. Sheep raising was once an important enterprise, but the number of sheep raised has decreased from 26,121 in 1930 to 4,425 in 1954.

TABLE 19.—*Acreage of the principal crops and number of fruit trees and grapevines of bearing age in stated years*

Crop	1929	1939	1949	1954
	Acres	*Acres*	*Acres*	*Acres*
Corn harvested for grain	1, 538	11, 974	8, 369	22, 499
Corn cut for silage	10, 608	11, 448	15, 081	20, 638
Small grains threshed or combined:				
Wheat	24, 835	34, 245	60, 859	51, 195
Oats	56, 350	55, 700	58, 314	64, 290
Barley	11, 155	17, 256	4, 927	1, 755
Rye	2, 612	2, 033	825	1, 176
Buckwheat	2, 073	696	669	956
Other grains	(1)	5, 680	4, 956	2, 147
Soybeans for all purposes	87	2, 959	138	444
Other dry field and seed beans harvested for beans	17, 886	45, 022	53, 006	32, 688
All hay	132, 755	102, 506	88, 234	96, 370
Alfalfa cut for hay	7, 743	47, 055	32, 709	51, 266
Timothy, clover, and mixtures of clover and grasses cut for hay	122, 244	47, 243	52, 353	42, 760
Small grains cut for hay	127	978	227	123
Other hay cut	2, 641	7, 230	2, 945	2, 221
Alfalfa seed harvested	100	11, 209	3, 291	774
Red clover seed harvested	(2)	(2)	6, 792	4, 515
Other field seed crops harvested	4, 945	5, 486	1, 053	902
Potatoes for home use or for sale	2, 142	1, 848	[3] 422	[4] 371
Vegetables harvested for sale	3, 296	490	2, 484	3, 263
Sugar beets harvested for sugar	1, 709	10, 757	8, 656	5, 731
Mint harvested for oil	(1)	365	(1)	(1)
	Number [5]	*Number* [5]	*Number* [5]	*Number*
Apple trees	123, 179	48, 612	31, 551	9, 586
Peach trees	2, 394	3, 903	11, 154	3, 473
Pear trees	6, 789	7, 369	5, 182	3, 490
Plum trees	3, 201	1, 320	1, 727	601
Cherry trees	3, 418	25, 213	4, 119	22, 405
Grapevines	6, 006	27, 708	3, 410	4, 149

[1] Not reported.
[2] Not reported separately.
[3] Does not include acreage for farms with less than 15 bushels harvested.
[4] Does not include acreage for farms with less than 20 bushels harvested.
[5] One year later than year at head of column.

TABLE 20.—*Number of livestock on farms in stated years*

Livestock	1930	1940	1950	1954
Cattle and calves	62, 884	[1] 67, 450	75, 150	85, 796
Milk cows	[2] 27, 501	[2] 33, 927	36, 044	38, 523
Horses and mules	13, 142	[1] 13, 439	3, 726	1, 375
Sheep and lambs	26, 121	[3] 14, 581	4, 200	4, 425
Hogs and pigs	6, 377	[4] 8, 802	4, 782	4, 963
Chickens	[1] 264, 088	[4] 288, 825	[4] 212, 726	[4] 275, 561

[1] Over 3 months old.
[2] One year earlier than year at head of column.
[3] Over 6 months old.
[4] Over 4 months old.

Glossary

Acidity. See pH.

Aggregate. Soil particles held together by internal forces in a single mass or cluster, such as a clod, prism, block, or granule. Many properties of an aggregate may differ from those of an equal mass of unaggregated soil.

Alkalinity. See pH.

Alluvial soil. Soils on transported and relatively recently deposited alluvial materials with little or no modification by the soil-forming processes.

Alluvium. Mineral or organic particles of different sizes deposited on flood plains by streams.

Available soil moisture. Moisture, in a soil, that plants can use. This moisture amounts to the difference in moisture content of an adequately drained soil (field capacity) and the moisture content when plants begin to wilt.

Calcareous. Containing enough calcium carbonate to cause effervescence (fizzing) when dilute hydrochloric acid is added.

Catena. A group of soils developed from similar parent materials but differing in natural drainage or relief, or both. In this report the term "natural toposequence" is used instead of catena.

Clay. As a soil separate, mineral soil particles less than 0.002 millimeter (0.000079 inch) in diameter. As a textural class, soil material that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coarse-textured soils. See Sandy soils.

Consistence, soil. The degree of cohesion and adhesion of soil particles or their resistance to separation or deformation of the aggregate. Soil consistence is commonly described as *compact, firm, friable, hard, loose, plastic, soft,* and *sticky.*

Compact. Consistence of moist soil. Term denotes a combination of firm consistence and close packing or arrangement of particles.

Firm. Consistence of moist soil. Soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Friable. Consistence of moist soil. Soil material crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together.

Hard. Consistence of dry soil. Soil material is moderately resistant to pressure; can be broken in hands without difficulty but is barely breakable between thumb and forefinger.

Loose. Consistence of moist or dry soil. Noncoherent.

Plastic. Consistence of wet soil. Soil material deforms under moderate pressure; wire formable.

Soft. Consistence of dry soil. Soil mass is very weakly coherent and fragile; breaks into powder or individual grains under very slight pressure.

Sticky. Consistence of wet soil. After pressure, soil material adheres to both thumb and finger and tends to stretch somewhat and pull apart rather than to pull free from either digit.

Depressional area. A low-lying area that does not have surface outlets for the water or has only poorly developed ones.

Drainage (a practice). Removal of excess water within the soil by surface or tile drains.

Drainage, natural. Natural drainage condition under which the soil developed.

Drainage, soil. (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, soil drainage refers to the frequency and duration of periods when the soil is free of saturation. For example, in well-drained soils, the water is removed readily, but not rapidly; in poorly drained soils, the root zone is waterlogged for long periods and the roots of ordinary crop plants cannot get enough oxygen.

Field capacity. The amount of water remaining in a soil after the free water has drained away. It is the greatest amount of moisture held by a soil after excess water has drained away following a rain or irrigation that has saturated the soil.

Fragipan. A compact soil horizon that contains little clay. When dry, a fragipan is very hard and brittle.

Genesis, soil. The mode of origin of soil. In describing soil genesis, special reference is given to the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift. Material picked up, carried, and deposited by glacial ice or by water that flows when the glacial ice melts. This material is deposited as stratified, sorted material or as unstratified till.

Glacial outwash. Sandy and gravelly materials deposited in layers on plains or in old glacial drainageways by water from melting glaciers.

Glacial till. Unstratified glacial drift that consists of clay, silt, sand, gravel, and boulders intermingled in any proportion.

Granular. See Soil structure.

Green-manure crop. Any crop grown and plowed under for the purpose of improving the surface layer of the soil profile, especially by addition of organic matter.

Great soil group. Any one of several broad groups of soils that have the same kind and sequence of horizons in the soil profile.

Horizon, soil. Layer or part of the soil profile, approximately parallel to the land surface, that has more or less well-defined characteristics.

Horizon A. The upper horizon of the soil profile from which material has been removed by percolating waters; the surface and subsurface layers; may include the cultivated part of the solum, or plow layer. The A horizon is generally subdivided in two or more subhorizons, of which A_0 and A_{00} are not a part of the mineral soil but are the accumulation of organic debris on the surface. Other subhorizons are designated as A_1, A_2, and A_3, depending on their properties.

Horizon B. The horizon of deposition, to which materials have been added by percolating waters; the illuviated part of the solum; the subsoil. This horizon may also be divided into several subdivisions, depending on the color, structure, consistence, or character of the material deposited. These layers are designated as B_1, B_2, and B_3, depending on their properties.

Horizon C. The horizon of partly weathered material (C_1) or of material unweathered in place (C_2). The material in the C horizon is similar to that in one or more of the overlying horizons.

Horizon D. Any stratum, such as hard rock or layers of clay or sand, that is not similar to the material from which the overlying soils were formed but that may have significance to the overlying soil.

Humus. The dark-colored, finely divided, well-decomposed, more or less stable part of the organic matter in mineral soils.

Leaching. Removal of materials in solution or suspension by water passing through the soil.

Liquid limit. The moisture content at which a soil material passes from the plastic to the liquid state.

Management unit, soil. Soils that are somewhat similar in characteristics and, therefore, respond in a similar way to the same kind of crop rotations, drainage practices, fertilization, or other management.

Maximum dry density (see also Optimum moisture content). In the standard compaction test, the highest oven-dry weight, in pounds per cubic feet of a soil, at optimum moisture content.

Mechanical analysis. A laboratory procedure for determining the percentages of the size groups of individual mineral particles in a soil sample.

Morphology. The physical, chemical, and biological constitution of the soil. This constitution is expressed in the arrangement of the horizons in the soil profile and by the texture, structure, reaction, content of organic matter, and other characteristics of these horizons.

Mottles. Spots, streaks, or splotches of color on soil material. The pattern of mottles can be described by naming their contrast (*faint, distinct,* or *prominent*); abundance (*few, common, many*); and size (*few, medium, coarse*).

Muck (see also Peat). Well-decomposed, dark organic soil that contains more than 30 percent organic matter by weight and occurs in places that have naturally poor drainage. If the plant material in a layer, or horizon, of an organic soil is so completely decomposed that the plant structure can no longer be identified, the material is called muck. If the plant structure can still be identified, the material is called peat.

Munsell color notations. A system for denoting the hue, value, and chroma of color. In this system, separate notations for hue, value, and chroma are combined to form the color designation. For example, in the Munsell color notation 10YR 3/2, the 10YR denotes the hue, the 3 denotes the value, and the 2 denotes the chroma (*15*).

Neutral, soil. A soil that is neither acid nor alkaline. In practice, a neutral soil, or horizon of a soil, has a pH value between 6.6 and 7.3.

Optimum moisture content. In the standard compaction test, the point at which a soil material that is compacted at successively higher moisture content reaches its maximum density.

Orterde. A granular soil horizon that has an accumulation of iron oxides and organic matter but is not cemented.

Ortstein. A hard, cemented horizon that has an accumulation of iron oxides and organic matter.

Parent material. The relatively unaltered, geological deposits that are similar to those from which at least part of the soil has developed. In Sanilac County, soils that formed from mineral materials in one general layer (one-storied materials) have a solum related to the C horizon. In soils that have two different general layers (two-storied materials), the parent material of upper horizons differs from that of the lower horizons.

Peat (see also Muck). Raw, relatively undecayed or slightly decomposed organic matter accumulated under very poor drainage.

Percent, slope. The number of vertical feet rise or fall of the land surface per 100 feet of horizontal distance.

pH. Term used to express the acidity or alkalinity of soil; reaction. The reaction of soil expressed in words and in pH values are as follows:

	pH
Extremely acid	below 4.5
Very strongly acid	4.5–5.0
Strongly acid	5.1–5.5
Medium acid	5.6–6.0
Slightly acid	6.1–6.5
Neutral	6.6–7.3
Mildly alkaline	7.4–7.8
Moderately alkaline	7.9–8.4
Strongly alkaline	8.5–9.0
Very strongly alkaline	9.1 and higher

The pH of the soil material in Sanilac County ranges from 3.0 to 8.3.

Plastic limit. The moisture content at which a soil material passes from the solid to the plastic state.

Plasticity index. The numerical difference between the liquid limit and the plastic limit.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction (see also pH). The degree of acidity or alkalinity of a soil horizon.

Sand. As a size group, individual mineral fragments that have diameters ranging from 0.05 millimeter (0.002 inch) to 2 millimeters (0.079 inch). As a textural class, soil material that contains 85 percent or more sand and not more than 10 percent clay.

Sandy soils. A broad term for sand and loamy sand textural classes; soil with more than 70 percent sand and less than 15 percent clay.

Series, soil. A group of soils, generally formed from the same kind of parent material, that have soil horizons similar in their differentiating characteristics, except for the texture of the surface soil, and similar in their arrangement in the soil profile. The soil series is an important category in detailed soil classification. Individual series are named for places near which they were first mapped. Thus Au Gres, Guelph, McBride, Marlette, and Rubicon are names of soil series in Sanilac County.

Silt. As a size group, mineral particles ranging from 0.05 millimeter (0.002 inch) to 0.002 millimeter (0.000079 inch) in diameter; as a textural class, soil material that contains 80 percent or more silt and less than 12 percent clay.

Slope. *See* Percent slope.

Soil. The natural medium for the growth of land plants. The soil has layers, or horizons, that are the result of the integrated effect of climate and living matter, especially vegetation, on geological deposits, conditioned by relief, over periods of time.

Soil association. A group of soils that occur together in a characteristic pattern.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons. Usually the characteristics of the material in these horizons are quite unlike those of the underlying parent material. Roots and animal life are largely confined to the solum.

Structure, soil. The arrangement of the soil particles into lumps, granules, or other aggregates. Structure is described by grade (*weak, moderate,* or *strong*), that is, the distinctness and durability of the aggregates; by the size of the aggregates (*very fine, fine, medium, coarse,* or *very coarse*); and their shape (*platy, prismatic, columnar, blocky, granular,* or *crumb*). A soil is described as structureless if there are no observable aggregates. Structureless soils may be massive (coherent) or single grain (noncoherent).

Blocky, angular. Aggregates are block shaped; they may have flat or rounded surfaces that join at sharp angles.

Blocky, subangular. Aggregates have some rounded and some plane surfaces; vertices are rounded.

Columnar. Aggregates are prismatic and are rounded at the upper ends.

Crumb. Generally soft, small, porous aggregates, irregular, but tending toward a spherical shape, as in the A_1 horizons of many soils. Crumb structure is closely related to granular structure but is porous, whereas granular is nonporous.

Granular. Roughly spherical, firm small aggregates that may be either hard or soft but are generally more firm than crumb and without the distinct faces of blocky structure.

Platy. Soil particles are arranged around a plane, usually horizontal.

Prismatic. Soil particles are arranged around a vertical line; aggregates have flat, vertical surfaces.

Texture. The relative proportions of sand, silt, and clay in a mass of soil. A coarse-textured soil is one high in sand; fine-textured soil has a large proportion of clay.

Toposequence. See Catena.

Type, soil. A subclass, or category, under the soil series that is based on the texture of the surface layer. Except for texture of the surface layer, soils of the same type have horizons that are similar in differentiating characteristics and arrangement in the soil profile.

Weathering. The physical and chemical disintegration and decomposition of rocks and minerals. Soil is the result of weathering and other chemical, physical, and biological alterations that have changed the upper part of the earth's crust through various periods of time.

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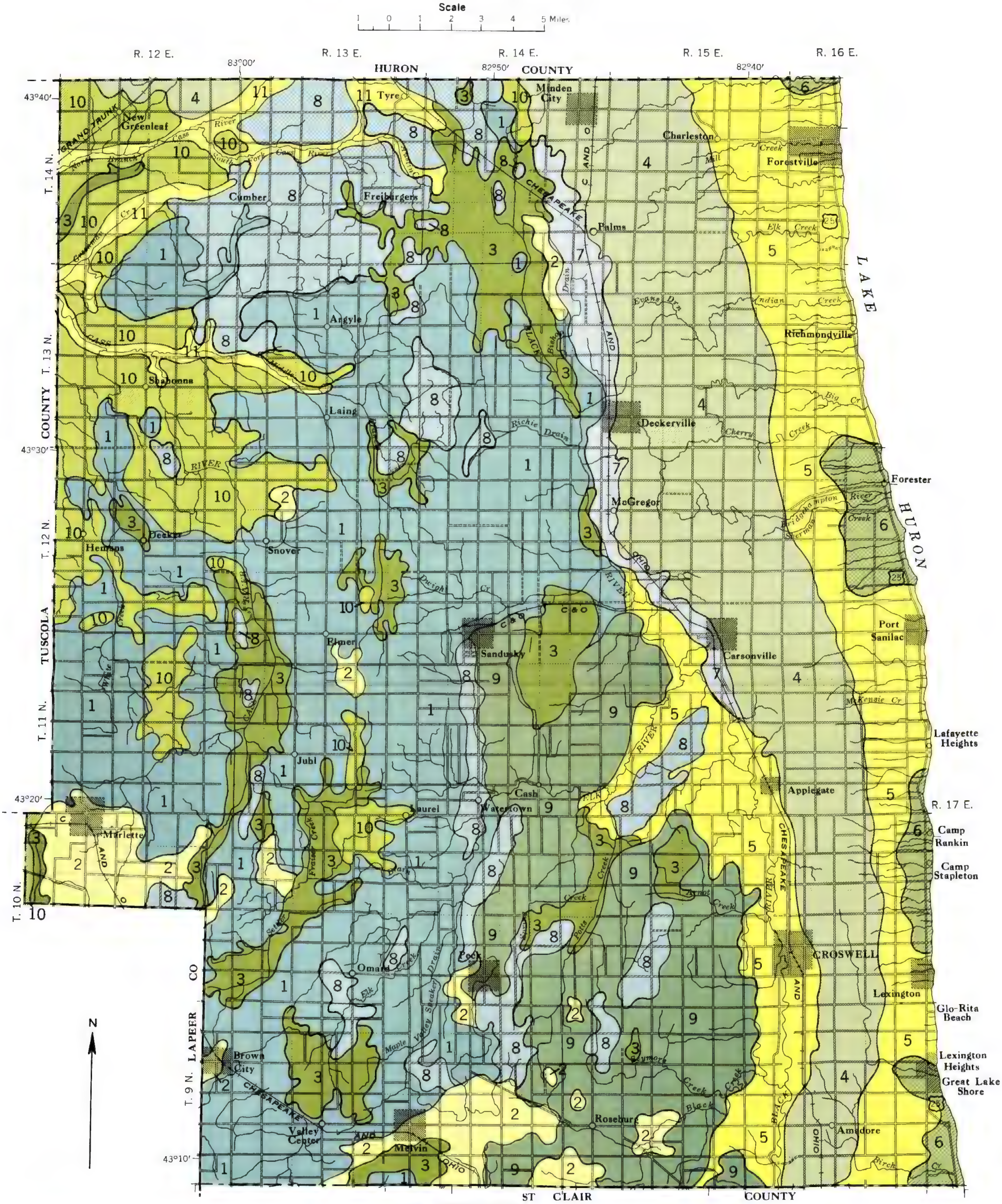
GENERAL SOIL MAP
SANILAC COUNTY, MICHIGAN



SOIL ASSOCIATIONS

1	Nearly level to undulating, poorly to imperfectly drained, dark grayish-brown to black, neutral sandy loams and loams: Parkhill, Capac, and organic soils.
2	Nearly level to rolling, well to poorly drained, light-brown to very dark grayish-brown, medium acid to neutral sandy loams and loams: Marlette, Capac, and organic soils.
3	Level, very poorly drained, black to dark grayish-brown, extremely acid to mildly alkaline peats and mucks.
4	Undulating to hilly, well to imperfectly drained, light-brown to very dark grayish-brown, slightly acid to neutral sandy loams and loams: Guelph and London.
5	Nearly level, imperfectly to very poorly drained, dark grayish-brown to black, medium acid to mildly alkaline loamy sands and clay loams: London, Iosco, and Saverine.
6	Level to undulating, well to imperfectly drained, very strongly acid to neutral sands: Melita, Arenac, Croswell, and Eastport.
7	Level to undulating, imperfectly to very poorly drained, grayish-brown to black, slightly acid to calcareous loamy sands to sandy loams: Palo, Gladwin, and Epoufette.
8	Undulating to hilly, well-drained, pale-brown to very dark grayish-brown or black, strongly to slightly acid loamy sands, sandy loams, and sands: Montcalm, McBride, and Rubicon.
9	Nearly level to undulating, very poorly to imperfectly drained, dark grayish-brown to nearly black, neutral and mildly alkaline loams and clay loams: Parkhill and Capac
10	Nearly level to rolling, well to poorly drained, pale-brown to very dark grayish-brown, strongly acid to neutral loamy sands to loams.
11	Level to undulating, poorly to imperfectly drained, dark grayish-brown to black, slightly acid to neutral sandy loams and loams.

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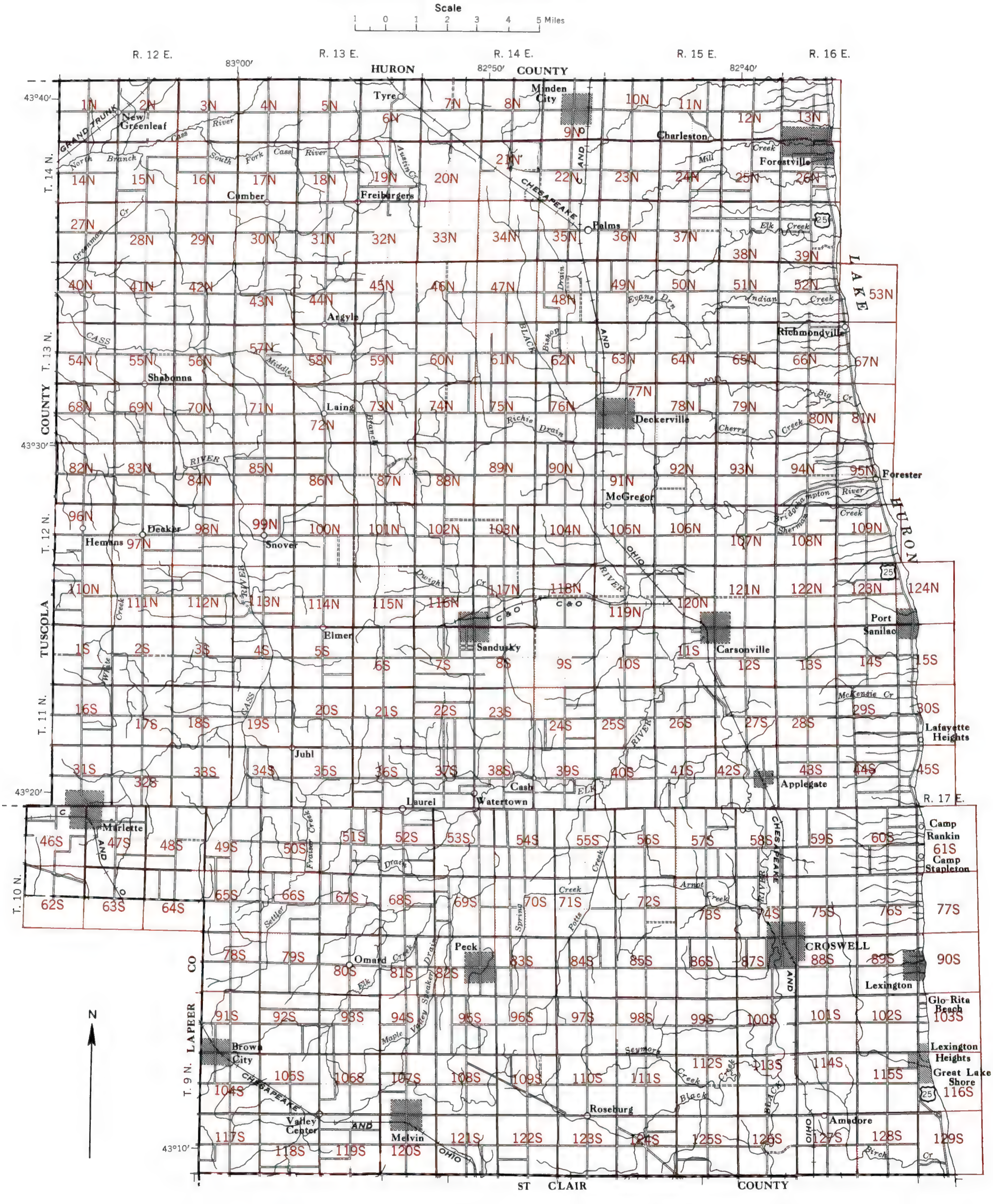
SANILAC COUNTY, MICHIGAN



SOIL LEGEND

SYMBOL	NAME
AaA0	Adrian muck, 0-2 percent slopes
AbA0	Alluvial land, poorly drained loams, 0-2 percent slopes
AbB0	Alluvial land, poorly drained loams, 2-6 percent slopes
AcA0	Alluvial land, imperfectly or moderately well drained sandy loams, 0-2 percent slopes
AcB0	Alluvial land, imperfectly or moderately well drained sandy loams, 2-6 percent slopes
AdA0	Alluvial land, poorly drained sandy loams, 0-2 percent slopes
AdB0	Alluvial land, poorly drained sandy loams, 2-6 percent slopes
AeA0	AuGres and Saugatuck loamy sands, 0-2 percent slopes
AeB1	AuGres and Saugatuck loamy sands, 2-6 percent slopes, slightly eroded
BaA0	Bach silt loam, 0-2 percent slopes
CaA0	Capac loam aad fine sandy loam, 0-2 percent slopes
CaB1	Capac loam and fine sandy loam, 2-6 percent slopes, slightly eroded
CaC2	Capac loam and fine sandy loam, 6-12 percent slopes, moderately eroded
CbA0	Capac silt loam and loam, 0-2 percent slopes
CbB1	Capac silt loam and loam, 2-6 percent slopes, slightly eroded
CbB2	Capac silt loam and loam, 2-6 percent slopes, moderately eroded
CcA0	Carlisle muck, 0-2 percent slopes
CdA0	Carlisle and Linwood mucks, 0-2 percent slopes
Ce	Clay pit
CfA0	Coral fine sandy loam, 0-2 percent slopes
CfB1	Coral fine sandy loam, 2-6 percent slopes, slightly eroded
CgA1	Croswell loamy sand, 0-2 percent slopes, slightly eroded
CgB1	Croswell loamy sand, 2-7 percent slopes, slightly eroded
EaA1	Eastport, Arenac, and Kalkaska sands, 0-2 percent slopes, slightly eroded
EaB1	Eastport, Arenac, and Kalkaska sands, 2-7 percent slopes, slightly eroded
EaC1	Eastport, Arenac, and Kalkaska sands, 7-14 percent slopes, slightly eroded
EbA0	Eastport fine sand and Beach sand, 0-2 percent slopes
EbC0	Eastport fine sand and Beach sand, 2-18 percent slopes
EcA0	Edmore and Ensley sandy loams, 0-2 percent slopes
EcB1	Edmore and Ensley sandy loams, 2-6 percent slopes, slightly eroded
EdA0	Edwards muck, 0-2 percent slopes
EeA0	Epoufette and Ronald sandy loams, 0-2 percent slopes
EeB1	Epoufette and Ronald sandy loams, 2-6 percent slopes, slightly eroded
GaC1	Gagetown silt loam, 6-12 percent slopes, slightly eroded
GaC2	Gagetown silt loam, 6-12 percent slopes, moderately eroded
GaD2	Gagetown silt loam, 12-18 percent slopes, moderately eroded
GbA0	Gladwin and Palo sandy loams, 0-2 percent slopes
GbB1	Gladwin and Palo sandy loams, 2-7 percent slopes, slightly eroded
Gc	Gravel pit
GdA0	Greenwood peat, 0-2 percent slopes
GeA1	Guelph loam, 0-2 percent slopes, slightly eroded
GeB1	Guelph loam, 2-6 percent slopes, slightly eroded
GeB2	Guelph loam, 2-6 percent slopes, moderately eroded
GeC1	Guelph loam, 6-12 percent slopes, slightly eroded
GeC2	Guelph loam, 6-12 percent slopes, moderately eroded
GeC3	Guelph loam, 6-12 percent slopes, severely eroded
GeD1	Guelph loam, 12-18 percent slopes, slightly eroded
GeD2	Guelph loam, 12-18 percent slopes, moderately eroded
GeD3	Guelph loam, 12-18 percent slopes, severely eroded
GfA1	Guelph loam and silt loam, 0-2 percent slopes, slightly eroded
GfA2	Guelph loam and silt loam, 0-2 percent slopes, moderately eroded
GfB1	Guelph loam and silt loam, 2-6 percent slopes, slightly eroded
GfB2	Guelph loam and silt loam, 2-6 percent slopes, moderately eroded
GfB3	Guelph loam and silt loam, 2-6 percent slopes, severely eroded
GfC1	Guelph loam and silt loam, 6-12 percent slopes, slightly eroded
GfC2	Guelph loam and silt loam, 6-12 percent slopes, moderately eroded
GfC3	Guelph loam and silt loam, 6-12 percent slopes, severely eroded
GfD1	Guelph loam and silt loam, 12-18 percent slopes, slightly eroded
GfD2	Guelph loam and silt loam, 12-18 percent slopes, moderately eroded
GfD3	Guelph loam and silt loam, 12-18 percent slopes, severely eroded
GfE1	Guelph loam and silt loam, 18+ percent slopes, slightly eroded
GfE2	Guelph loam and silt loam, 18+ percent slopes, moderately eroded
GfE3	Guelph loam and silt loam, 18+ percent slopes, severely eroded
HaA0	Houghton muck, 0-2 percent slopes
HbA0	Houghton and Palms mucks, 0-2 percent slopes
HcB1	Huron silt loam, 2-6 percent slopes, slightly eroded
IaA0	Iosco and Menominee loamy sands, 0-2 percent slopes
IaB1	Iosco and Menominee loamy sands, 2-6 percent slopes, slightly eroded
IbA0	Iosco and Winegars sandy loams, 0-2 percent slopes
IbB1	Iosco and Winegars sandy loams, 2-6 percent slopes, slightly eroded
IcA0	Iosco sandy loam and Croswell loamy sand, 0-2 percent slopes
IcB1	Iosco sandy loam and Croswell loamy sand, 2-7 percent slopes, slightly eroded
IcC1	Iosco sandy loam and Croswell loamy sand, 7-14 percent slopes, slightly eroded
IcD1	Iosco sandy loam and Croswell loamy sand, 14+ percent slopes, slightly eroded
JaA0	Jeddo silty clay loam, 0-2 percent slopes
KaA1	Kalkaska and Wallace fine sands, 0-2 percent slopes, slightly eroded
KaB1	Kalkaska and Wallace fine sands, 2-8 percent slopes, slightly eroded
KaC1	Kalkaska and Wallace fine sands, 8-18 percent slopes, slightly eroded
KbA0	Kerston muck, 0-2 percent slopes
La	Lake beach, sandy
Lb	Lake beach, rocky
Lc	Lake beach, stony
LdA0	Linwood muck, 0-2 percent slopes
LeA0	Linwood and Tawas mucks, 0-2 percent slopes
LfA0	London loam and fine sandy loam, 0-2 percent slopes
LfB1	London loam and fine sandy loam, 2-6 percent slopes, slightly eroded
LfB2	London loam and fine sandy loam, 2-6 percent slopes, moderately eroded
LgA0	London loam and silt loam, 0-2 percent slopes
LgB1	London loam and silt loam, 2-6 percent slopes, slightly eroded
LgB2	London loam and silt loam, 2-6 percent slopes, moderately eroded
LgC1	London loam and silt loam, 6-12 percent slopes, slightly or moderately eroded
MaA1	McBride fine sandy loam, 0-2 percent slopes, slightly eroded
MaB1	McBride fine sandy loam, 2-6 percent slopes, slightly eroded
MaB2	McBride fine sandy loam, 2-6 percent slopes, moderately eroded
MaC1	McBride fine sandy loam, 6-12 percent slopes, slightly eroded
MaC2	McBride fine sandy loam, 6-12 percent slopes, moderately eroded
MaD1	McBride fine sandy loam, 12-18 percent slopes, slightly eroded
MaD2	McBride fine sandy loam, 12-18 percent slopes, moderately eroded
MaD3	McBride fine sandy loam, 12-18 percent slopes, severely eroded
MbA1	McBride sandy loam and Montcalm loamy sand, 0-3 percent slopes, slightly eroded
MbB1	McBride sandy loam and Montcalm loamy sand, 3-8 percent slopes, slightly eroded
MbB3	McBride sandy loam and Montcalm loamy sand, 3-8 percent slopes, severely eroded
MbC1	McBride sandy loam and Montcalm loamy sand, 8-15 percent slopes, slightly eroded
MbC2	McBride sandy loam and Montcalm loamy sand, 8-15 percent slopes, moderately or severely eroded
MbD1	McBride sandy loam and Montcalm loamy sand, 15-25 percent slopes, slightly eroded
MbE3	McBride sandy loam and Montcalm loamy sand, 15+ percent slopes, moderately or severely eroded
McA0	McGregor sandy loam, 0-2 percent slopes
McB1	McGregor sandy loam, 2-6 percent slopes, slightly eroded
Md	Made land
MeA1	Mancelona loamy sand, 0-3 percent slopes, slightly eroded
MeB1	Mancelona loamy sand, 3-8 percent slopes, slightly eroded
MeB2	Mancelona loamy sand, 3-8 percent slopes, moderately eroded
MeC1	Mancelona loamy sand, 8-15 percent slopes, slightly eroded
MeC2	Mancelona loamy sand, 8-15 percent slopes, moderately eroded
MeD1	Mancelona loamy sand, 15+ percent slopes, slightly eroded
MeD2	Mancelona loamy sand, 15+ percent slopes, moderately eroded
MeD3	Mancelona loamy sand, 15+ percent slopes, severely eroded
MfA1	Marlette loam, 0-2 percent slopes, slightly eroded
MfB1	Marlette loam, 2-6 percent slopes, slightly eroded
MfB2	Marlette loam, 2-6 percent slopes, moderately eroded
MfB3	Marlette loam, 2-6 percent slopes, severely eroded
MfC1	Marlette loam, 6-12 percent slopes, slightly eroded
MfC2	Marlette loam, 6-12 percent slopes, moderately eroded
MfC3	Marlette loam, 6-12 percent slopes, severely eroded
MfD1	Marlette loam, 12-18 percent slopes, slightly eroded
MfD2	Marlette loam, 12-18 percent slopes, moderately eroded
MfD3	Marlette loam, 12-18 percent slopes, severely eroded
MfE2	Marlette loam, 18-25 percent slopes, moderately eroded
MgA1	Marlette silt loam and loam, 0-2 percent slopes, slightly eroded
MgB1	Marlette silt loam and loam, 2-6 percent slopes, slightly eroded
MgB2	Marlette silt loam and loam, 2-6 percent slopes, moderately eroded
MgC1	Marlette silt loam and loam, 6-12 percent slopes, slightly eroded
MgC2	Marlette silt loam and loam, 6-12 percent slopes, moderately eroded
MhA1	Melita and Arenac loamy sands, 0-2 percent slopes, slightly eroded
MhB1	Melita and Arenac loamy sands, 2-7 percent slopes, slightly eroded
MkC1	Melita loamy sand, 7-14 percent slopes, slightly eroded
MkD2	Melita loamy sand, 14+ percent slopes, slightly to severely eroded
MmC1	Menominee loamy sand, 6-12 percent slopes, slightly eroded
MmC2	Menominee loamy sand, 6-12 percent slopes, moderately eroded
MnA1	Montcalm loamy sand, 0-2 percent slopes, slightly eroded
MnB1	Montcalm loamy sand, 2-6 percent slopes, slightly eroded
MnB2	Montcalm loamy sand, 2-6 percent slopes, moderately eroded
MnC1	Montcalm loamy sand, 6-12 percent slopes, slightly eroded
MnC2	Montcalm loamy sand, 6-12 percent slopes, moderately eroded
MnD1	Montcalm loamy sand, 12-18 percent slopes, slightly eroded
MnD2	Montcalm loamy sand, 12-18 percent slopes, moderately eroded
NaA1	Newaygo sandy loam, 0-2 percent slopes, slightly eroded
NaB1	Newaygo sandy loam, 2-6 percent slopes, slightly eroded
NaC1	Newaygo sandy loam, 6-12 percent slopes, slightly eroded
NaC2	Newaygo sandy loam, 6-12 percent slopes, moderately eroded
OaA0	Otisco loamy sand, 0-2 percent slopes
OaB1	Otisco loamy sand, 2-6 percent slopes, slightly eroded
PaA0	Palms muck, 0-2 percent slopes
PbA0	Palms and Adrian mucks, 0-2 percent slopes
PcA0	Parkhill loam, 0-2 percent slopes
PcB1	Parkhill loam, 2-6 percent slopes, slightly eroded
PdA0	Parkhill loam and clay loam, 0-2 percent slopes
PeA0	Parkhill loam and mucky loam, 0-2 percent slopes
PfA0	Perth silt loam, 0-2 percent slopes
RaA0	Richter and Tonkey bouldery sandy loam and loam, 0-2 percent slopes
RaB1	Richter and Tonkey bouldery sandy loam and loam, 2-6 percent slopes, slightly eroded
RbA0	Rifle peat, 0-2 percent slopes
RcA0	Roscommon loamy sand, 0-2 percent slopes
RdA0	Roscommon mucky loamy sand, 0-2 percent slopes
ReA1	Rubicon sand, 0-2 percent slopes, slightly eroded
ReB1	Rubicon sand, 2-7 percent slopes, slightly eroded
ReB3	Rubicon sand, 2-7 percent slopes, moderately or severely eroded
ReC1	Rubicon sand, 7-14 percent slopes, slightly eroded
ReC2	Rubicon sand, 7-14 percent slopes, moderately or severely eroded
ReD1	Rubicon sand, 14+ percent slopes, slightly eroded
ReD3	Rubicon sand, 14+ percent slopes, moderately or severely eroded
SaA0	Sanilac silt loam, 0-2 percent slopes
SaB1	Sanilac silt loam, 2-6 percent slopes, slightly eroded
SbA0	Saverine and Iosco fine sandy loams, 0-2 percent slopes
SbB1	Saverine and Iosco fine sandy loams, 2-7 percent slopes, slightly eroded
SbB2	Saverine and Iosco fine sandy loams, 2-7 percent slopes, moderately eroded
SbC1	Saverine and Iosco fine sandy loams, 7-14 percent slopes, slightly eroded
SbC2	Saverine and Iosco fine sandy loams, 7-14 percent slopes, moderately eroded
SbD1	Saverine and Iosco fine sandy loams, 14+ percent slopes, slightly eroded
SbD2	Saverine and Iosco fine sandy loams, 14+ percent slopes, moderately eroded
ScA0	Spalding peat, 0-2 percent slopes
TaA0	Tappan loam, 0-2 percent slopes
TbA0	Tappan mucky loam, 0-2 percent slopes
TcA0	Tawas muck, 0-2 percent slopes
TdA0	Thomas mucky silt loam, 0-2 percent slopes
TeA0	Tobico mucky loamy sand, 0-2 percent slopes
TfA0	Tonkey sandy loam, 0-2 percent slopes
TgA0	Tonkey and Bach fine sandy loams, 0-2 percent slopes
TgB1	Tonkey and Bach fine sandy loams, 2-7 percent slopes, slightly eroded
ThA0	Tyre loamy sand and sandy loam, 0-2 percent slopes
ThB1	Tyre loamy sand and sandy loam, 2-6 percent slopes, slightly eroded
ThC1	Tyre loamy sand and sandy loam, 6-12 percent slopes, slightly eroded
WaA0	Wallkill loam, 0-2 percent slopes
WbA0	Warners muck and Marl, 0-2 percent slopes
WcA0	Washtenaw loam and silt loam, 0-2 percent slopes
WcB0	Washtenaw loam and silt loam, 2-6 percent slopes
WdA0	Washtenaw sandy loam and loam, 0-2 percent slopes
WdB0	Washtenaw sandy loam and loam, 2-6 percent slopes
WeA0	Willette muck, 0-2 percent slopes

Soils surveyed 1940-55 by Ivan F. Schneider, Michigan Agricultural Experiment Station, and D. R. Gardner and H. H. Bailey, U. S. Department of Agriculture. Correlation by O. C. Rogers, Soil Conservation Service, and E. P. Whiteside, Michigan Agricultural Experiment Station.

The first capital letter is the initial one of the soil name. A second capital letter A, B, C, D, or E shows the slope. Symbols without a slope letter are those of undifferentiated land types. A final zero (0) in the symbol shows that the soil is not eroded, and a number 1, 2, or 3 shows the class of erosion.

Soil map constructed by Cartographic Division, Soil Conservation Service, USDA, from 1950 aerial photographs. Controlled mosaic based on polyconic projection, 1927 North American datum.

Scale 1:15 840

0 ½ 1 Mile

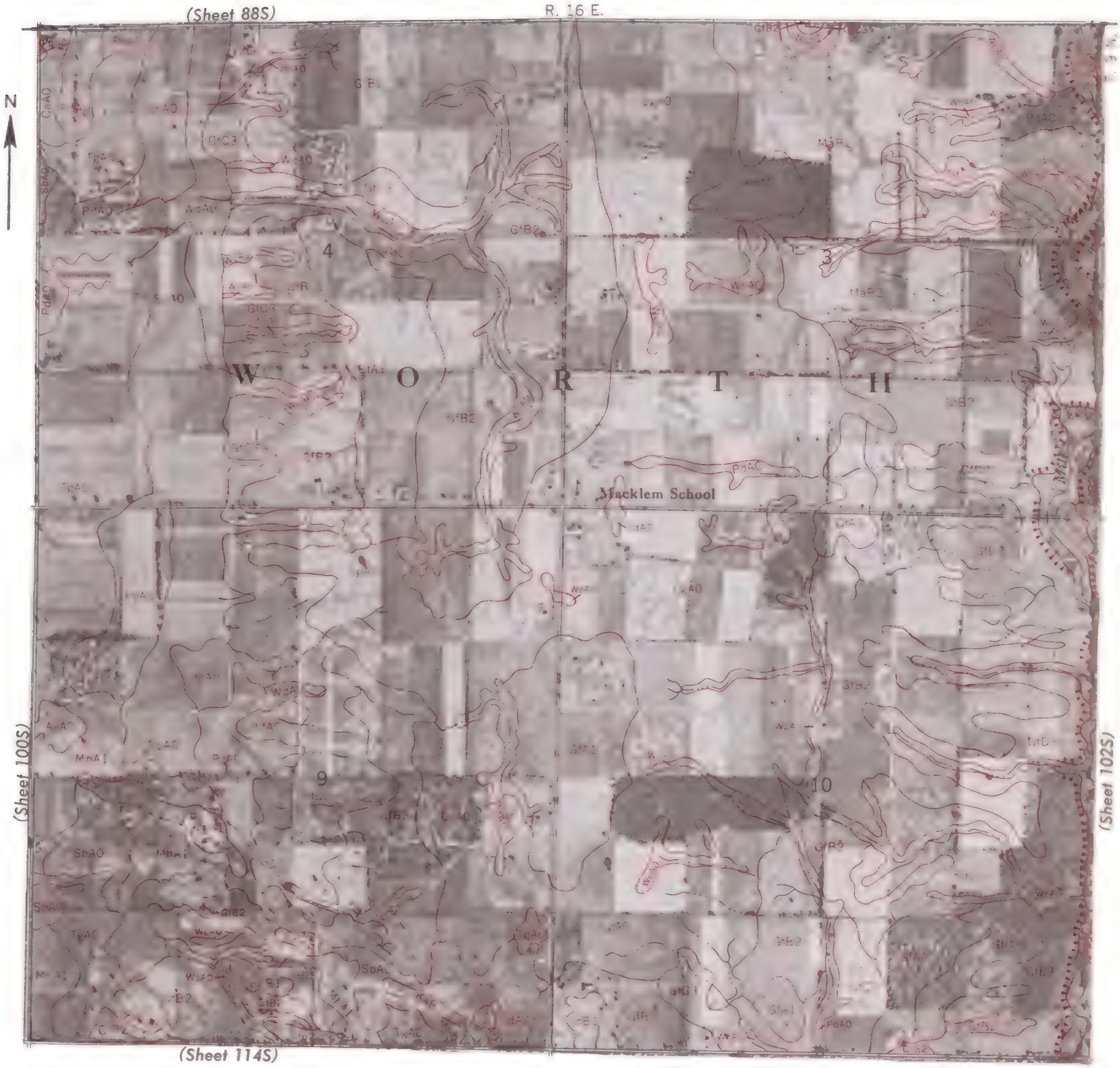
0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 87N)
R. 13 E.
N
14
13
M O O R E
T. 12 N.
(Sheet 100N)
(Sheet 102N)
23
24
(Sheet 115N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

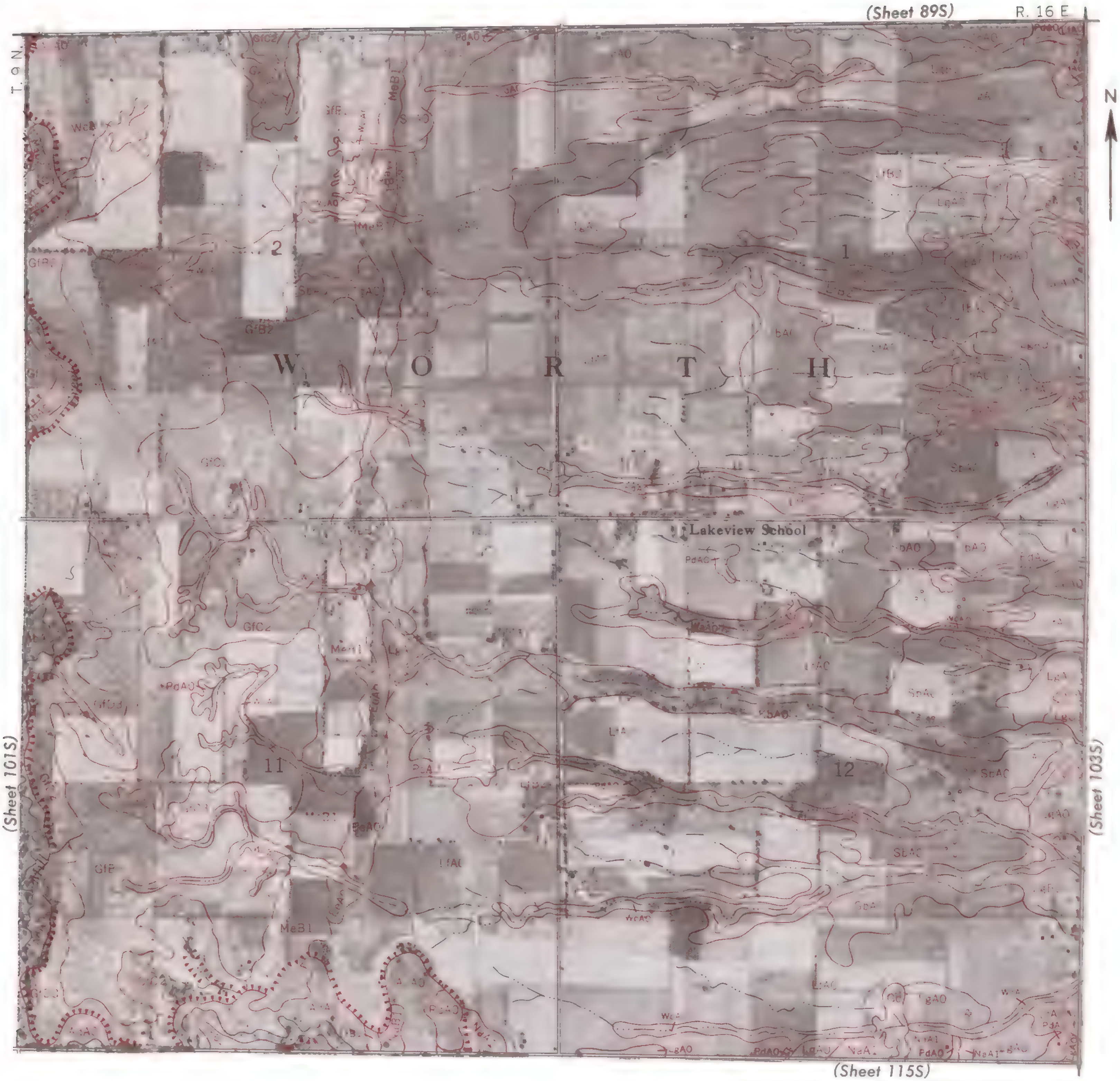


Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

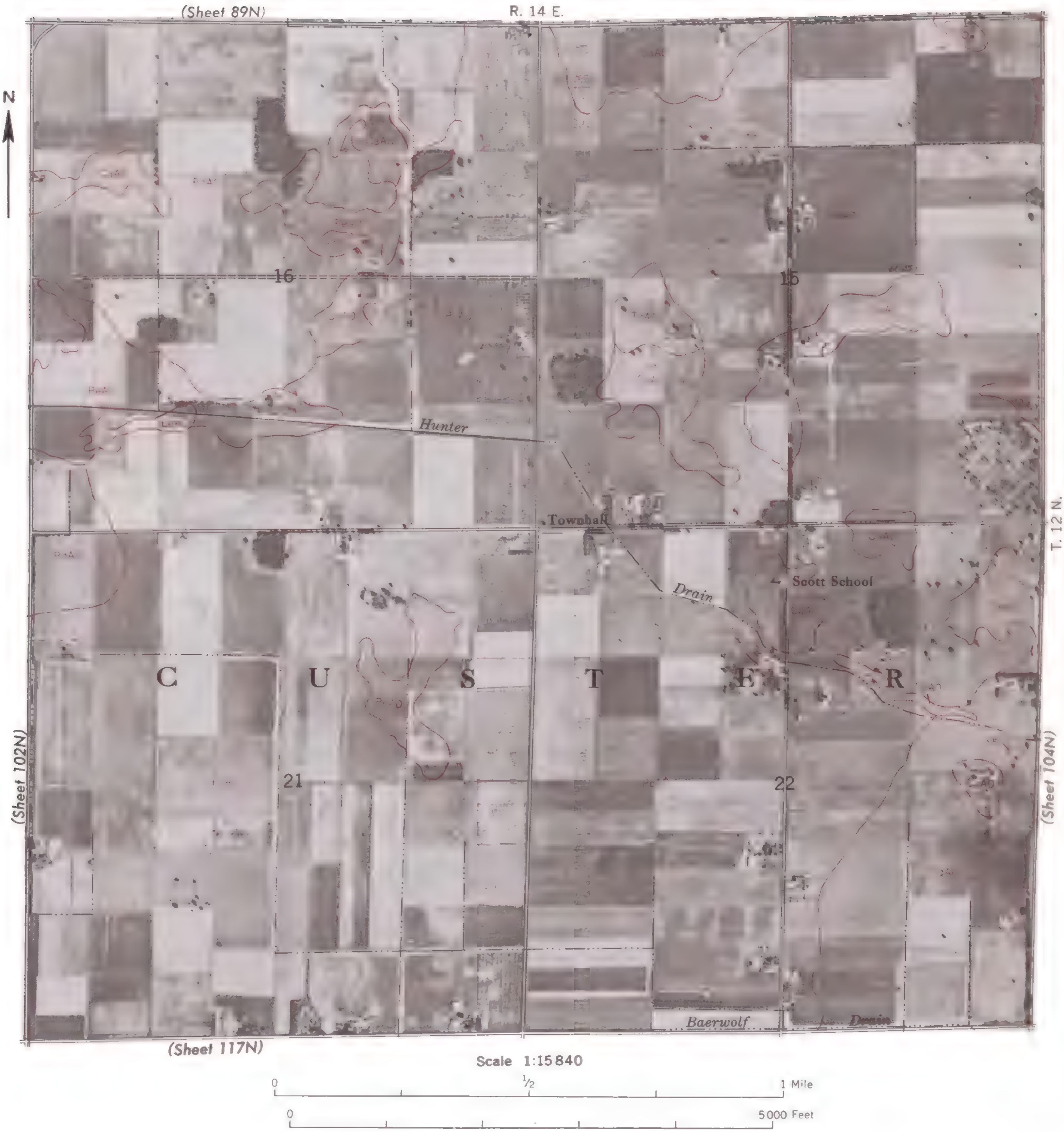

R. 14 E.
(Sheet 88N)
N
T. 12 N.
18
17
19
20
C U S T E R
Drain
LdAO
Bolshy School
(Sheet 101N)
(Sheet 103N)
(Sheet 116N)
Scale 1:15840
0
½
1 Mile
0
5000 Feet

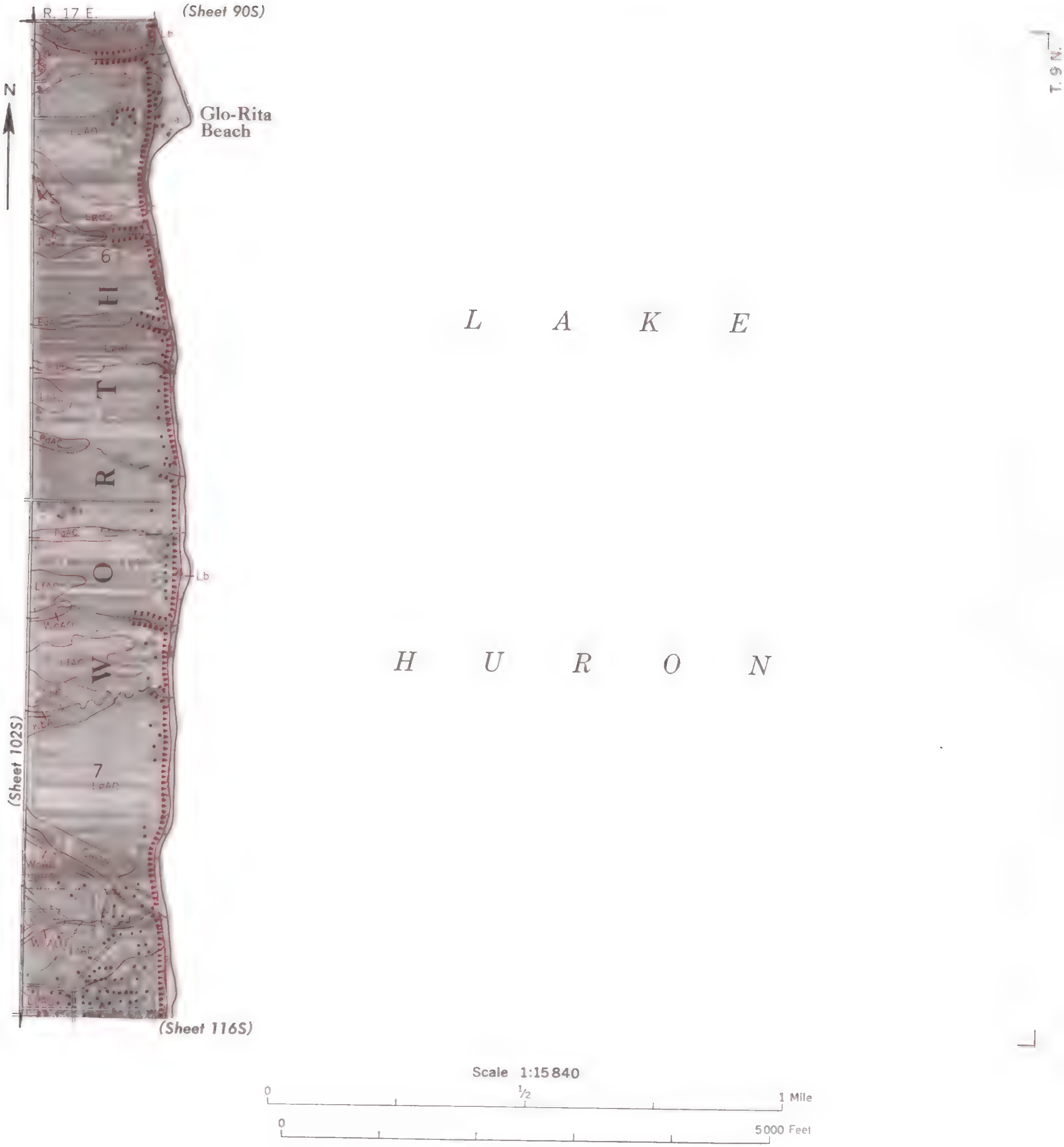


Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 89N)
R. 14 E.
N
16
15
Hunter
Townhall
Drain
Scott School
C U S T E R
21
22
Baerwolf
Drain
T. 12 N.
(Sheet 102N)
(Sheet 104N)
(Sheet 117N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


R. 17 E.
(Sheet 90S)
N
Glo-Rita
Beach
6
WORTH
Lb
7
(Sheet 102S)
(Sheet 116S)
LAKE
HURON
T. 9 N.
Scale 1:15 840
0
½
1 Mile
0
5 000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

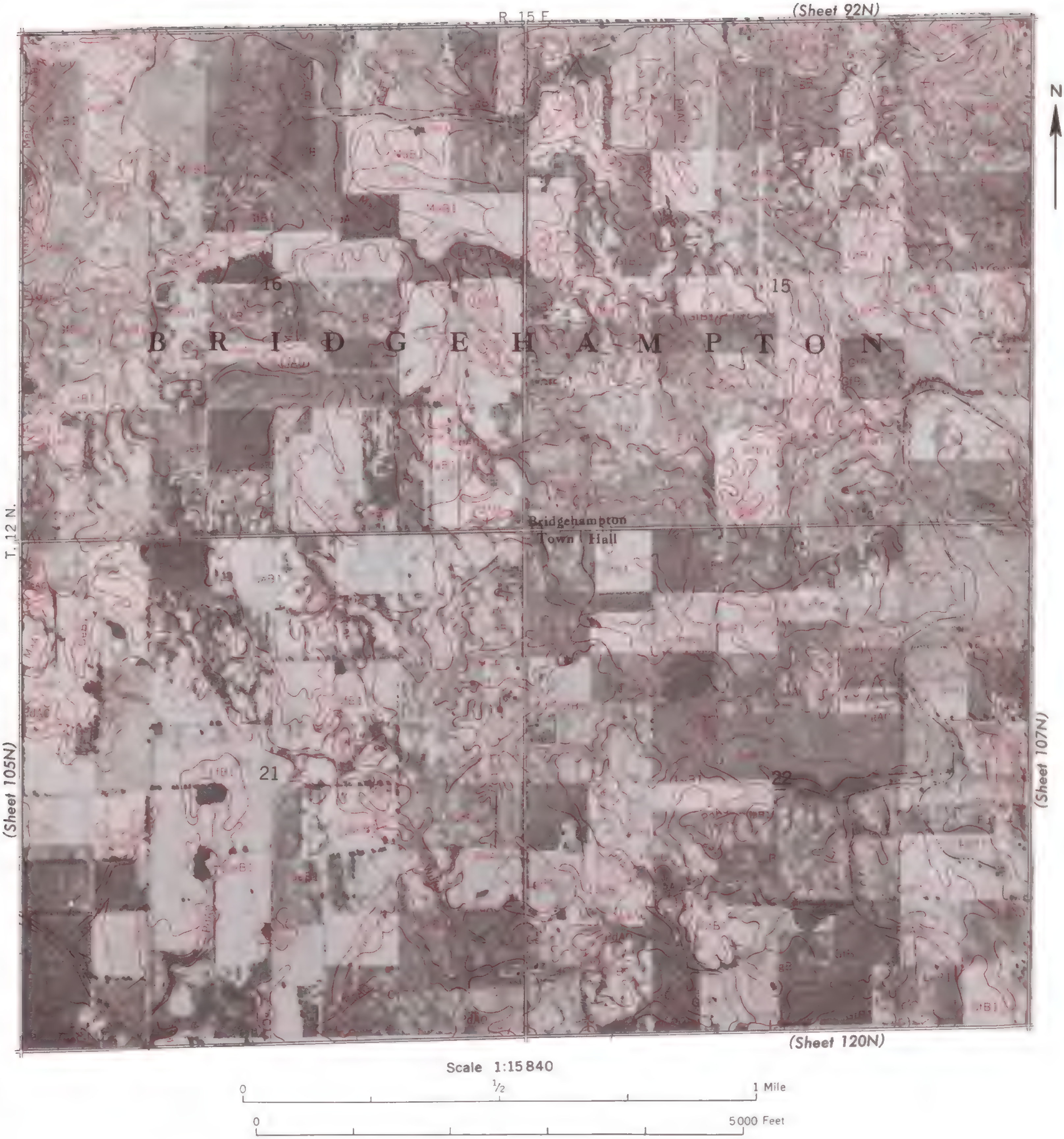
0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

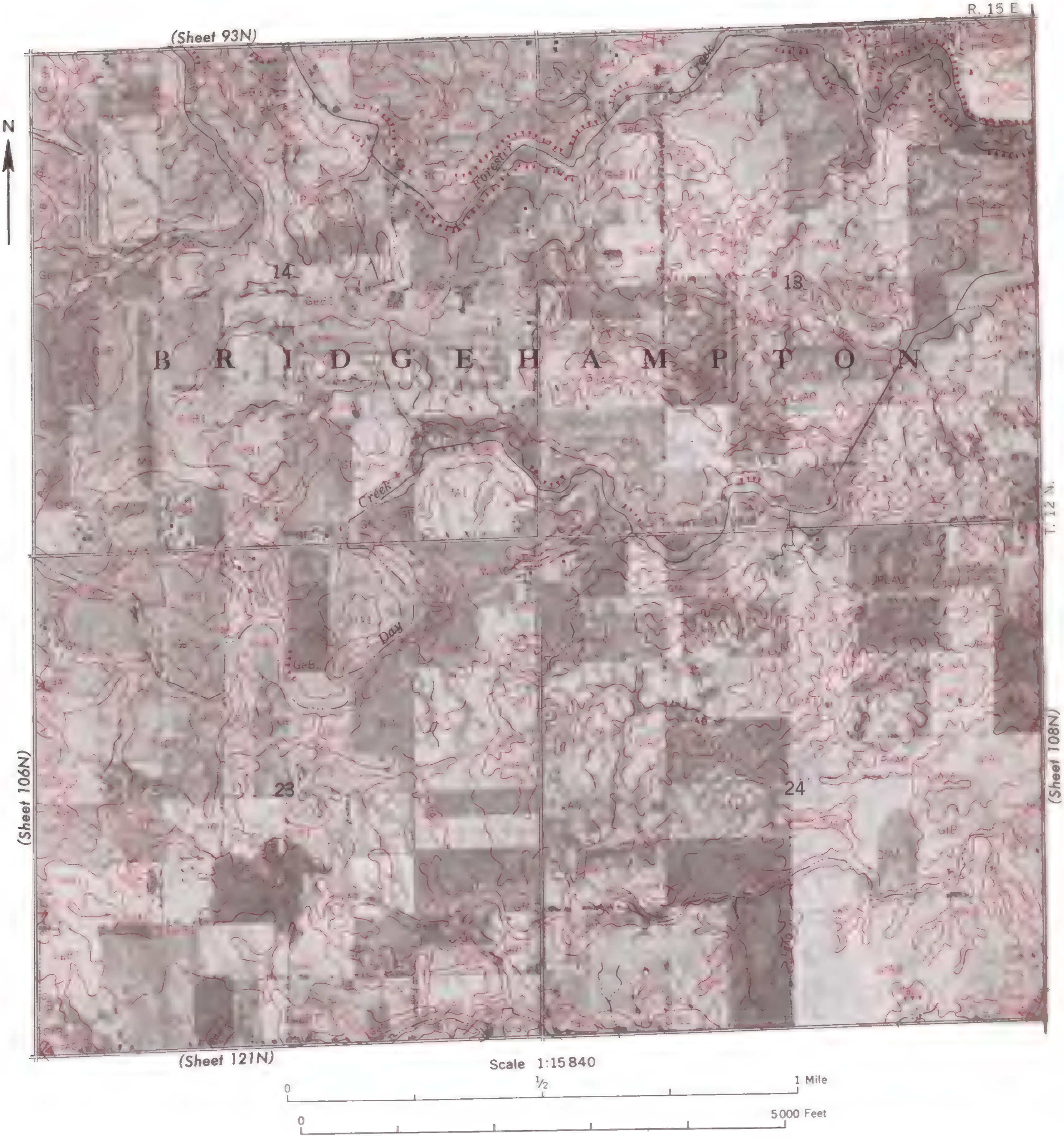
0 5000 Feet


R. 15 E.
(Sheet 92N)
N
16
15
B R I D G E H A M P T O N
Bridgehampton
Town Hall
T. 12 N.
(Sheet 105N)
(Sheet 107N)
21
22
(Sheet 120N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

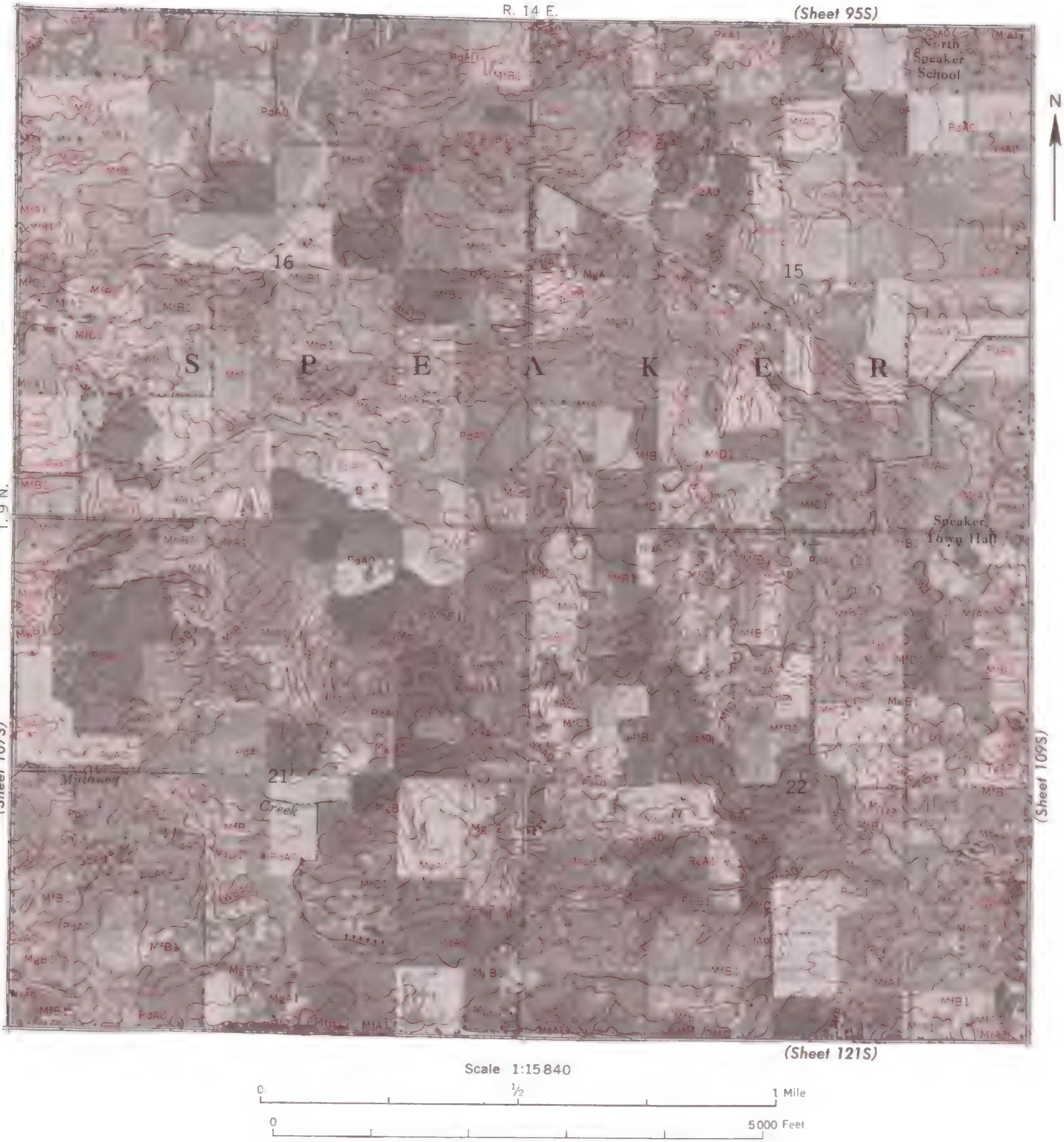

(Sheet 93N)
R. 15 E.
N
14
13
BRIDGEHAMPTON
Forest
Creek
Day
T. 12 N.
23
24
(Sheet 106N)
(Sheet 108N)
(Sheet 121N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


R. 16 E.
(Sheet 94N)
N
Creek
Forest
Creek
Day
18
17
F O R E S T E R
T. 12 N.
S A N I L A C
19
20
(Sheet 107N)
(Sheet 109N)
(Sheet 122N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 14 E.
(Sheet 95S)
North Speaker School
N
16
15
S P E A K E R
T. 9 N.
Speaker Town Hall
(Sheet 107S)
(Sheet 109S)
21
22
Mill Creek
(Sheet 121S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet


(Sheet 95N)
R. 16 E.
N
LAKE HURON
T. 12 N.
23
R. 16 E.
16
15
F O R E S T E R
SbAO
SbA
LAKE HURON
T. 12 N.
S A N I L A C
(Sheet 108N)
21
22
Cottage School
(Sheet 123N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


HURON COUNTY
R. 15 E.
T. 14 N.
N
6
5
D E L A W A R E
Delaware School
Dist. 2
7
8
(Sheet 9N)
(Sheet 11N)
(Sheet 23N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

(Sheet 119N)
R. 15 E.
T. 11 N.
N
BLACK RIVER
Gordon Drain
6
5
PdA0
W A S H I N G T O N
7
8
McPherson Drain
Recore Drain
(Sheet 9S)
(Sheet 11S)
(Sheet 25S)
Scale 1:15840
0
1/2
1 Mile
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet

Scale 1:15 840

0 ½ 1 Mile

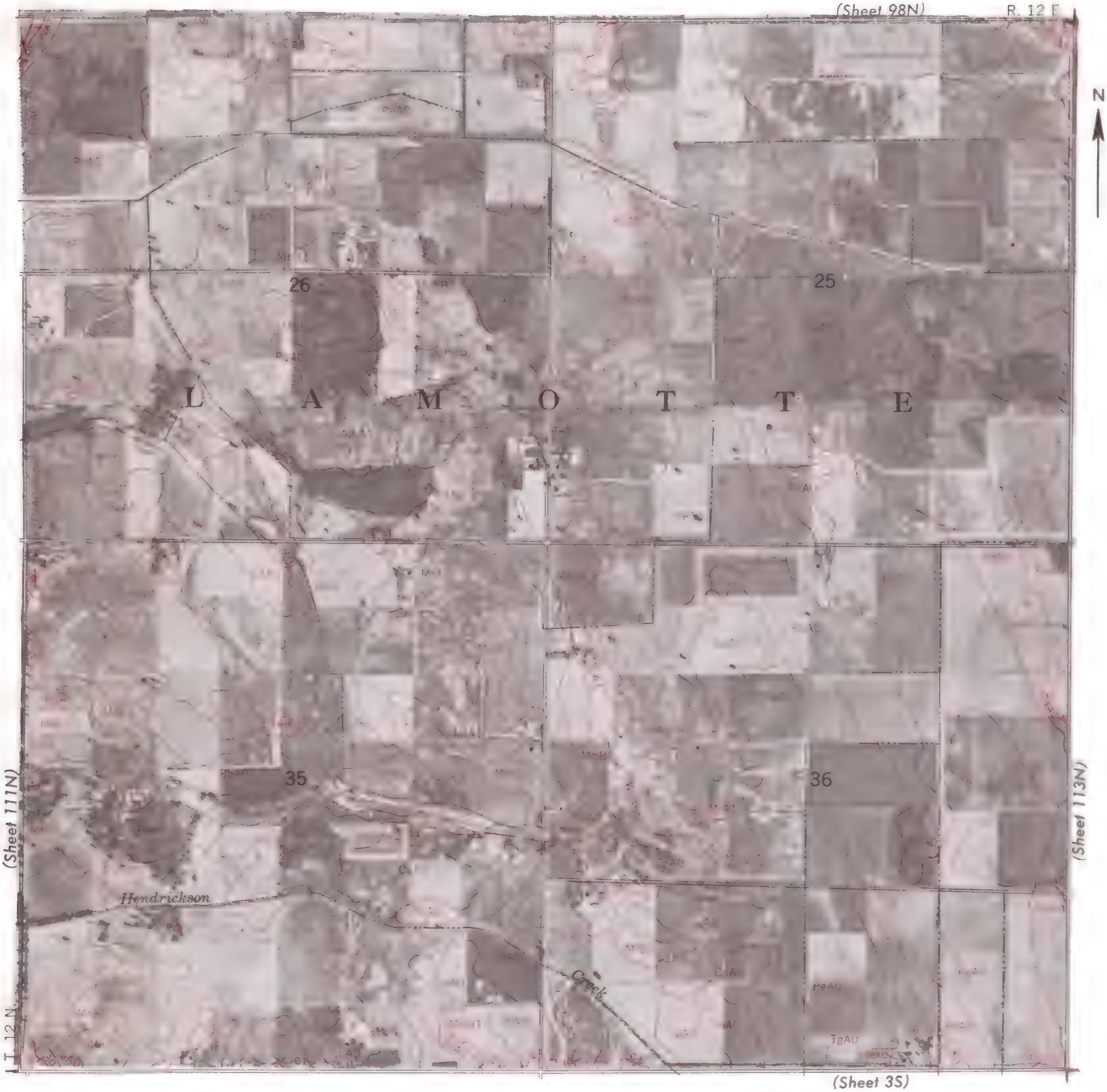
0 5000 Feet

Scale 1:15840

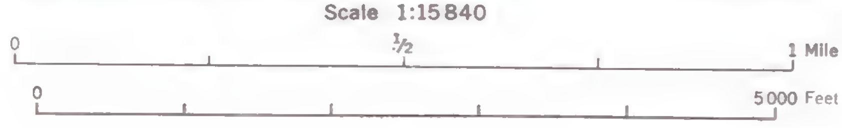
0 ½ 1 Mile

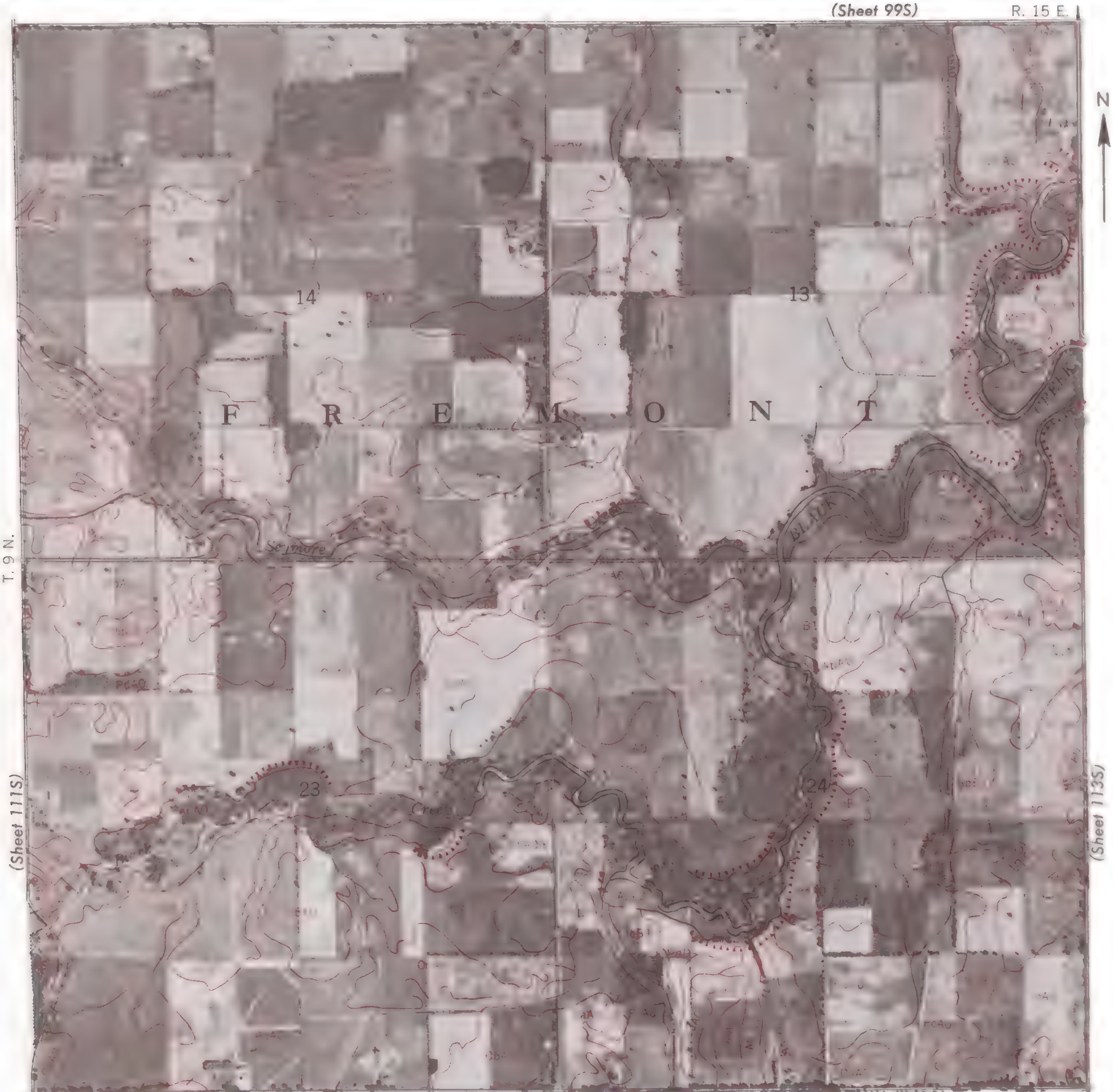
0 5000 Feet


(Sheet 98S)
R. 15 E.
N
16
15
F R E M O N T
Fremont Town Hall
T. 9 N.
21
22
(Sheet 110S)
(Sheet 112S)
Seymore Creek
Black Creek
(Sheet 124S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet



Scale 1:15 840





Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


R. 13 E.
(Sheet 99N)
N
30
29
M O O R E
31
32
Moore Cemetery
Minard School
(Sheet 112N)
(Sheet 114N)
T. 12 N.
(Sheet 4S)
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840


R. 13 E.
(Sheet 100N)
N
28
27
M O O R E
Elmer School
33
34
Elmer
(Sheet 113N)
(Sheet 115N)
T. 12 N.
(Sheet 5S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet


R. 16 E.
(Sheet 101S)
N
16
15
W O R T H
21
22
T. 9 N.
(Sheet 113S)
(Sheet 115S)
Amadore School
Scale 1:15 840
(Sheet 127S)
0
½
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

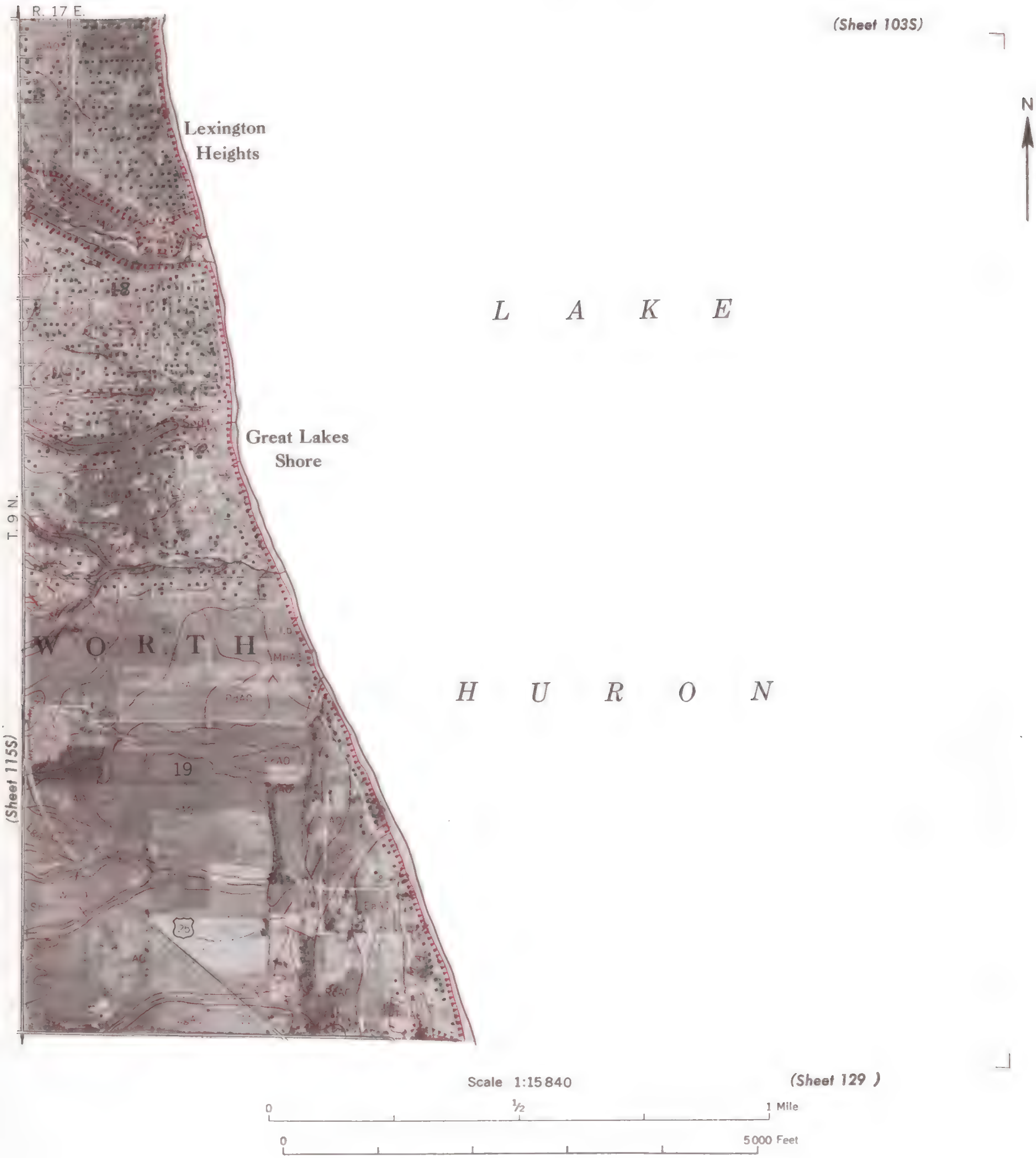
0 5000 Feet


(Sheet 102S)
R. 16 E.
N
14
13
W O R T H
T. 9 N.
23
24
(Sheet 114S)
(Sheet 116S)
(Sheet 128S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

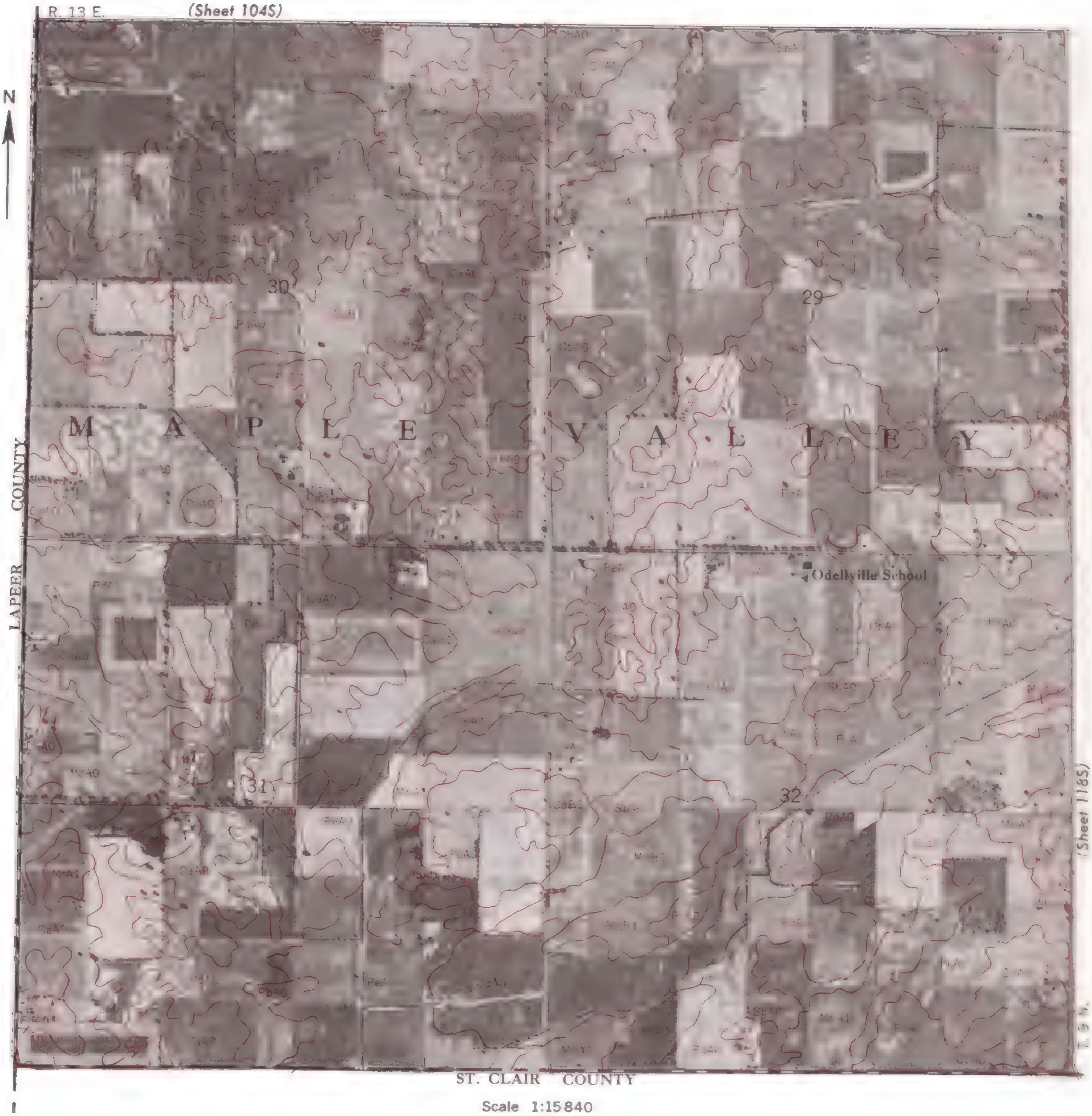
0 5000 Feet


R. 17 E.
(Sheet 103S)
N
Lexington
Heights
18
L A K E
Great Lakes
Shore
T. 9 N.
W O R T H
H U R O N
(Sheet 115S)
19
(Sheet 129)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15 840

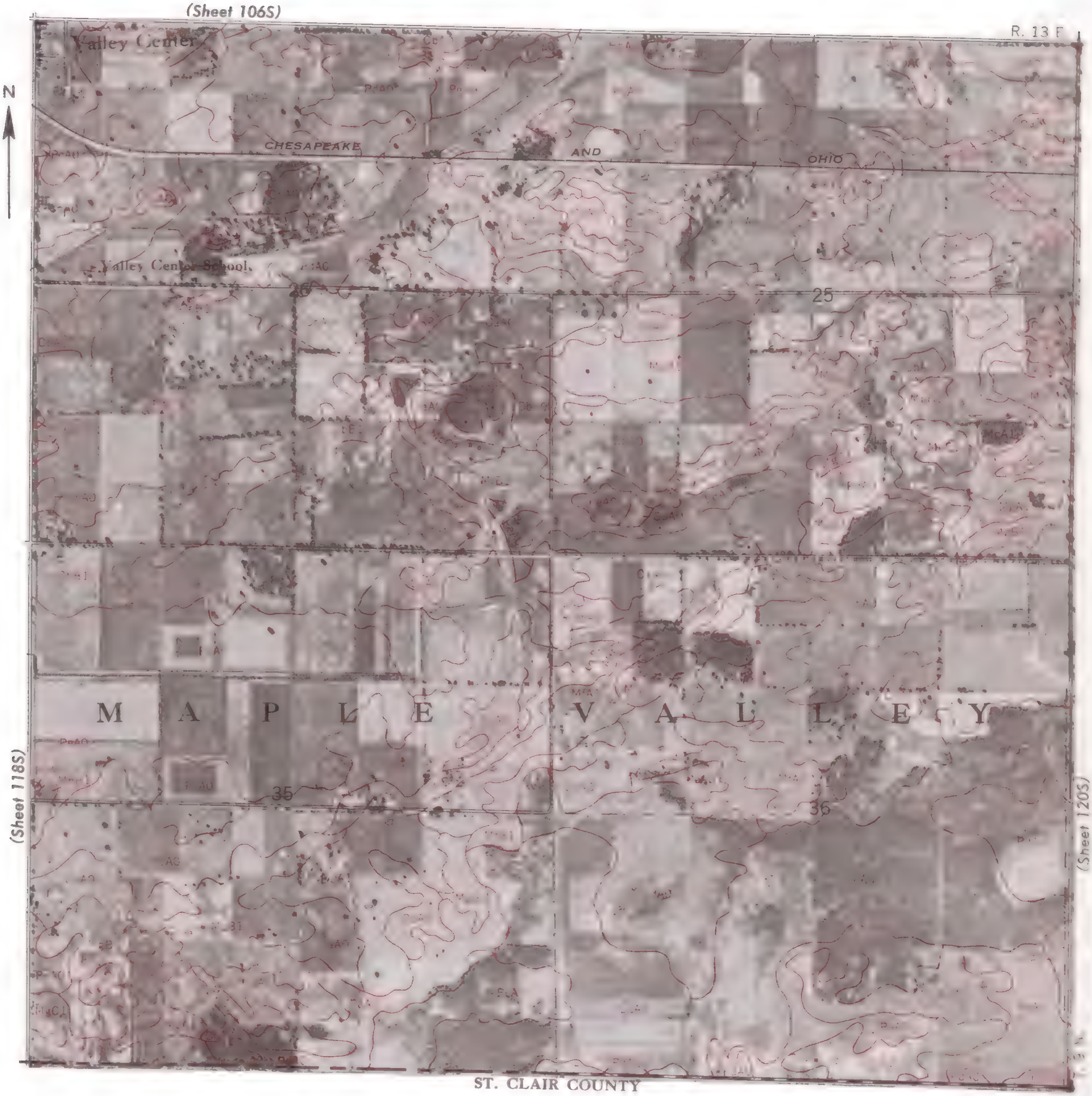
0 ½ 1 Mile

0 5000 Feet


(Sheet 104N)
R. 14 E.
N
Baerwolf
Drain
Fye Drain
Berry Drain
26
25
C U S T E R
CHESAPEAKE AND OHIO
35
36
(Sheet 117N)
(Sheet 119N)
T. 12 N.
(Sheet 9S)
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet


R. 13 E.
(Sheet 105S)
N
28
27
M A P L E V A L L E Y
33
34
(Sheet 117S)
(Sheet 119S)
T. 9 N.
ST. CLAIR COUNTY
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 15 E.
(Sheet 105N)
N
30
29
B R I D G E H A M P T O N
CHESAPEAKE AND OHIO
BLACK
RIVER
AND
OHIO
CHESAPEAKE
31
32
(Sheet 118N)
(Sheet 120N)
T. 12 N.
Black River School
(Sheet 10S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

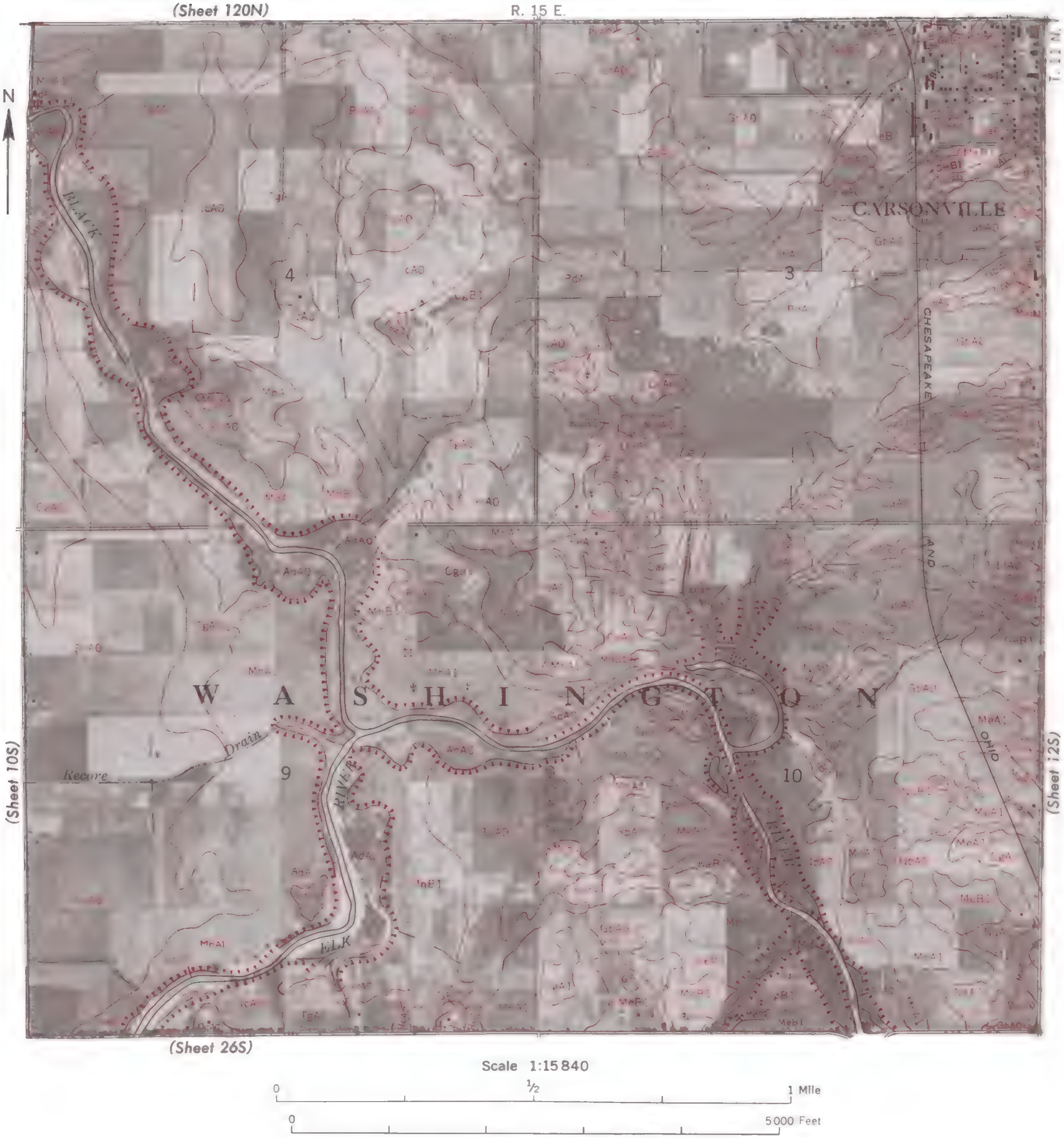


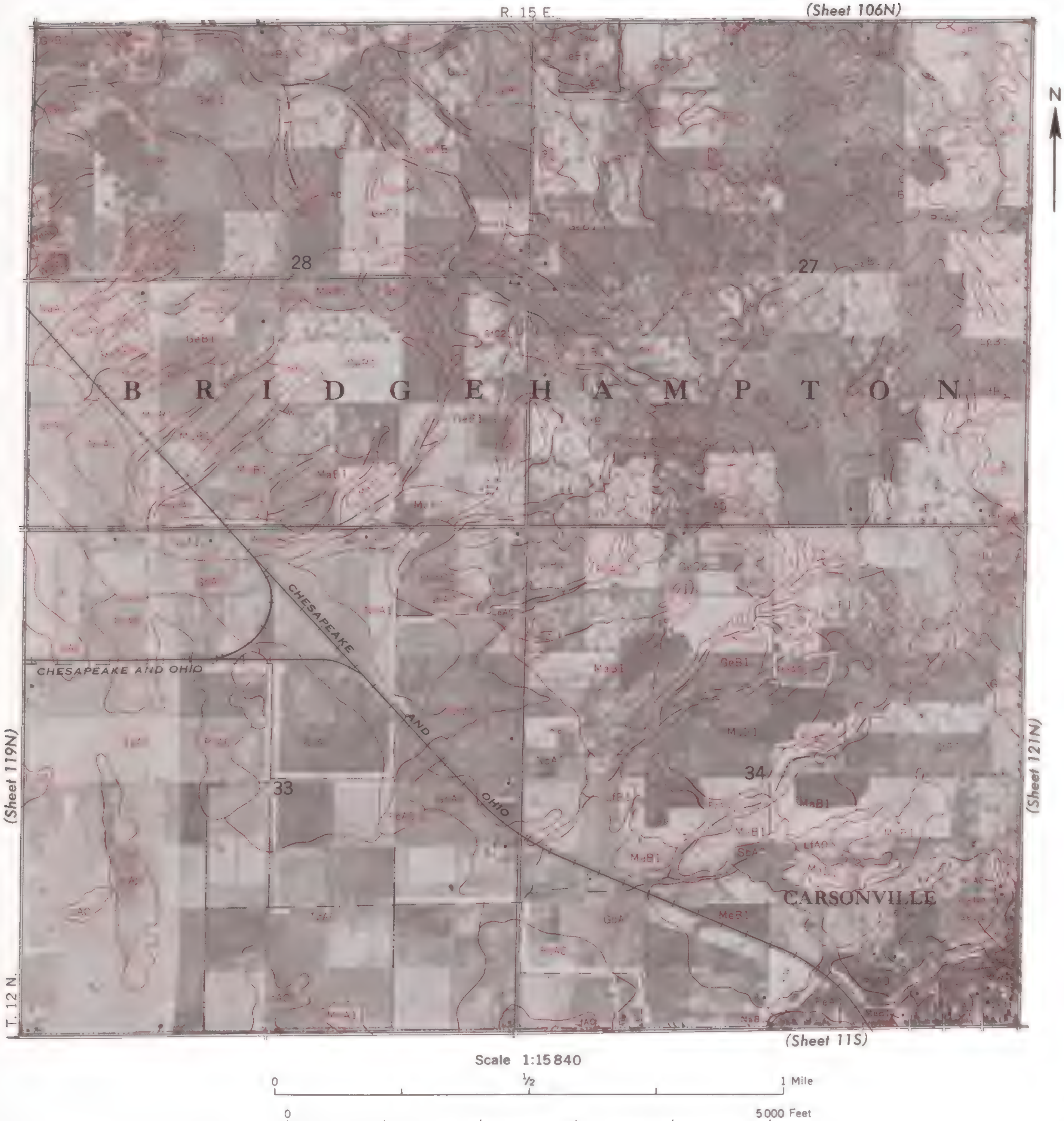
Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet


HURON R. 15 E. COUNTY
T. 14 N.
N
D E L A W A R E
4
3
9
10
Charleston
(Sheet 10N)
(Sheet 12N)
(Sheet 24N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


(Sheet 120N)
R. 15 E.
T. 11 N.
N
CARSONVILLE
CHESAPEAKE AND OHIO
BLACK
RIVER
WASHINGTON
Recore Drain
ELK
4
3
9
10
(Sheet 10S)
(Sheet 12S)
(Sheet 26S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 15 E.
(Sheet 106N)
N
28
27
BRIDGEHAMPTON
CHESAPEAKE AND OHIO
CHESAPEAKE AND OHIO
(Sheet 119N)
(Sheet 121N)
33
34
CARSONVILLE
T. 12 N.
(Sheet 11S)
Scale 1:15 840
0
½
1 Mile
0
5 000 Feet

Scale 1:15 840

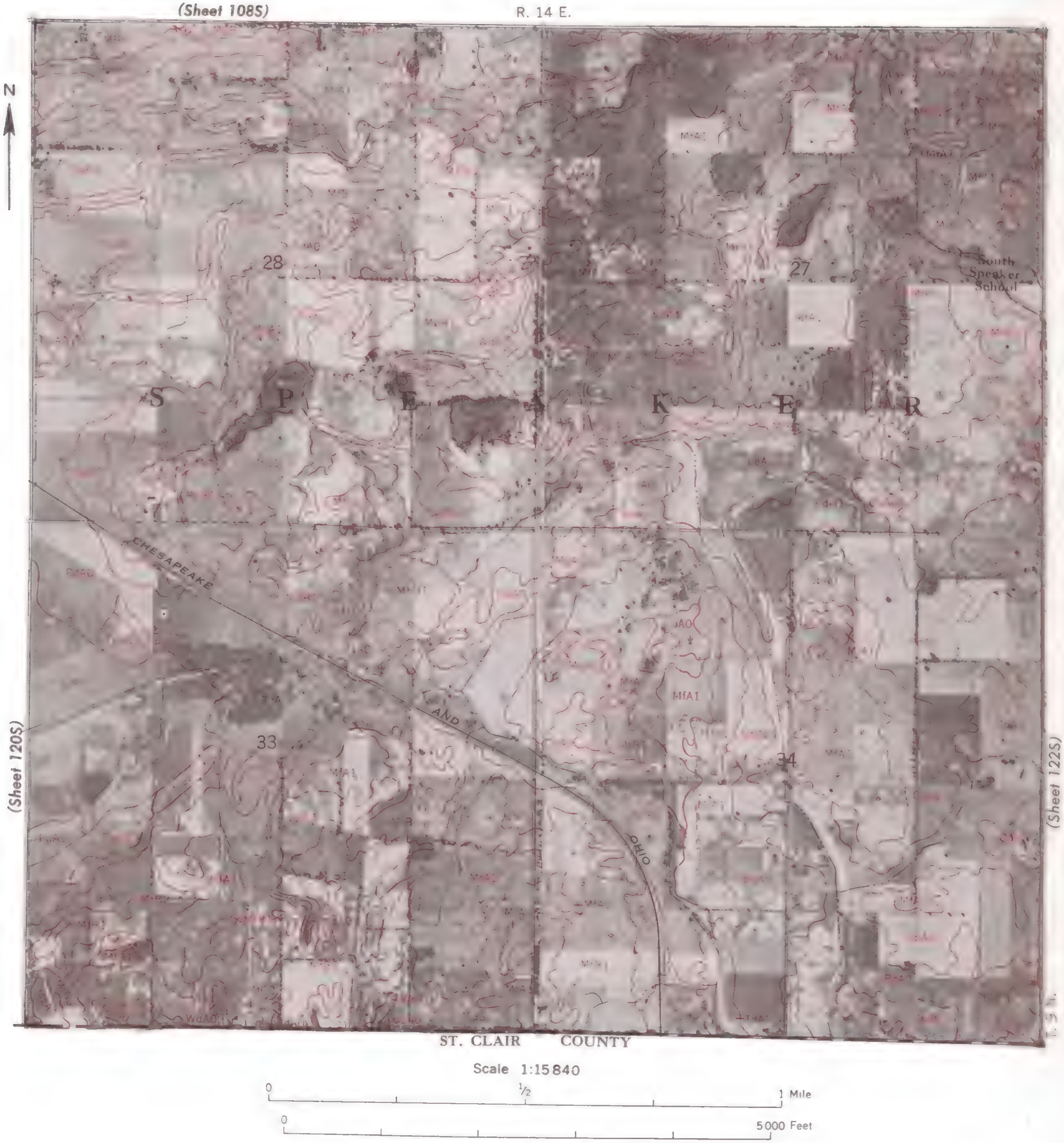
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

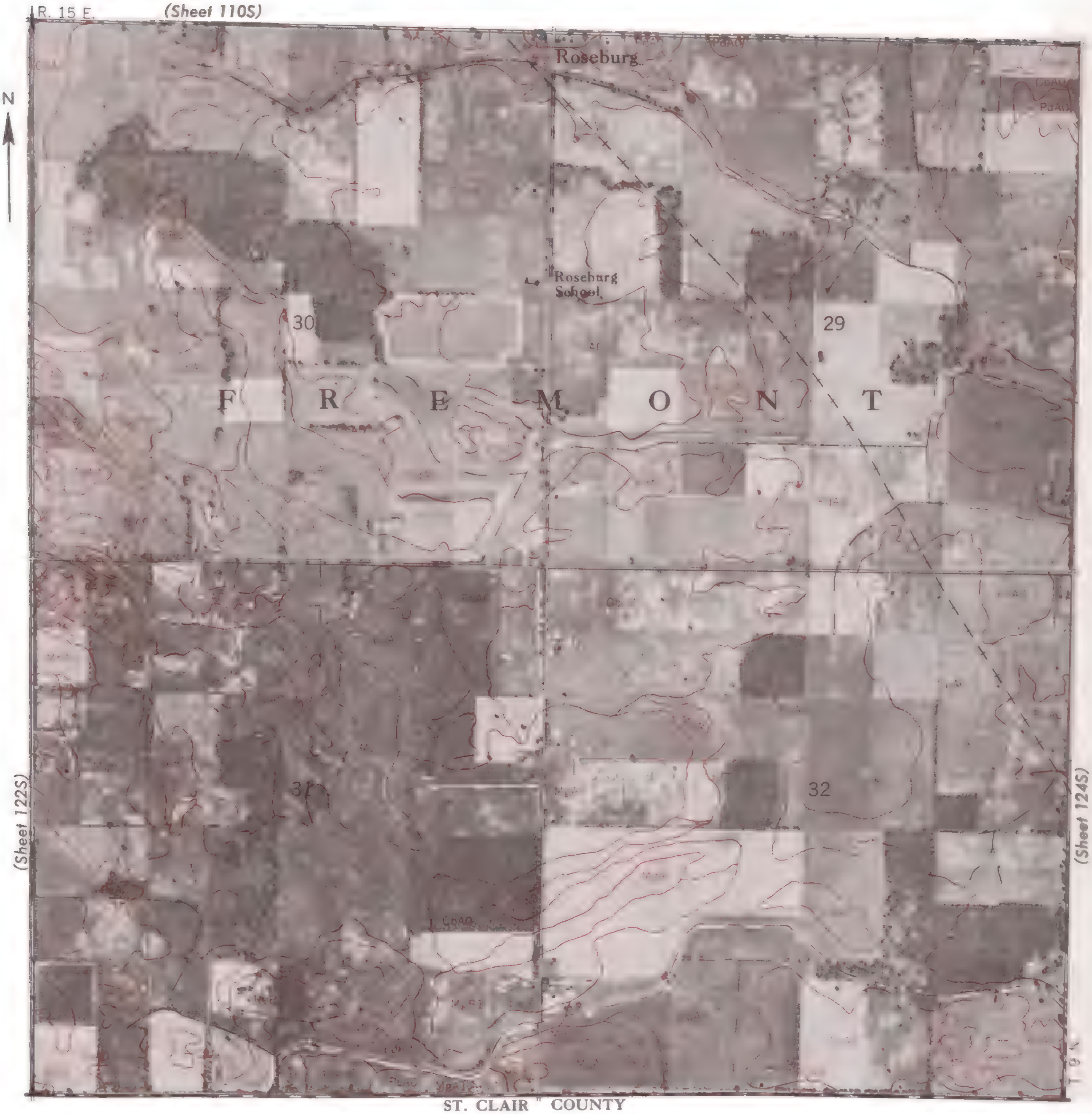
0 5000 Feet


(Sheet 108S)
R. 14 E.
N
28
27
South
Speaker
School
S P E A K E R
CHESAPEAKE
AND
OHIO
MfA1
33
34
(Sheet 120S)
(Sheet 122S)
ST. CLAIR COUNTY
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet


(Sheet 108N)
R. 16 E.
N
30
29
S A N I L A C
31
32
(Sheet 121N)
(Sheet 123N)
T. 12 N.
(Sheet 13S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


(Sheet 109S)
R. 14 E.
N
Foster School
26
25
S P E A K E R
35
36
(Sheet 121S)
(Sheet 123S)
T. 9 N.
ST. CLAIR COUNTY
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet


(Sheet 109N)
R. 16 E.
N
28
27
S A N I L A C
33
34
(Sheet 122N)
(Sheet 124N)
(Sheet 14S)
Scale 1:15 840
0
½
1 Mile
0
5 000 Feet

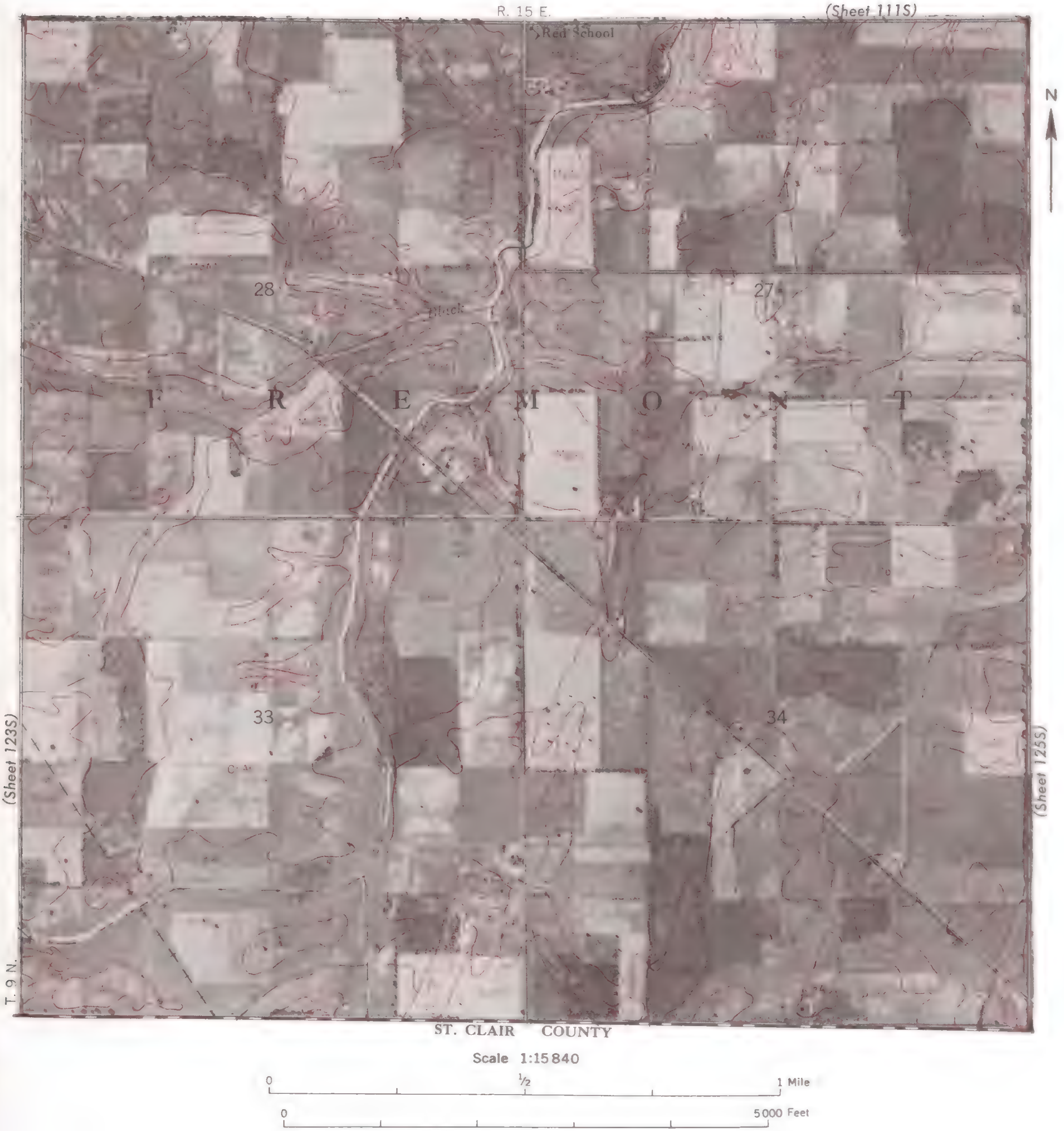


Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

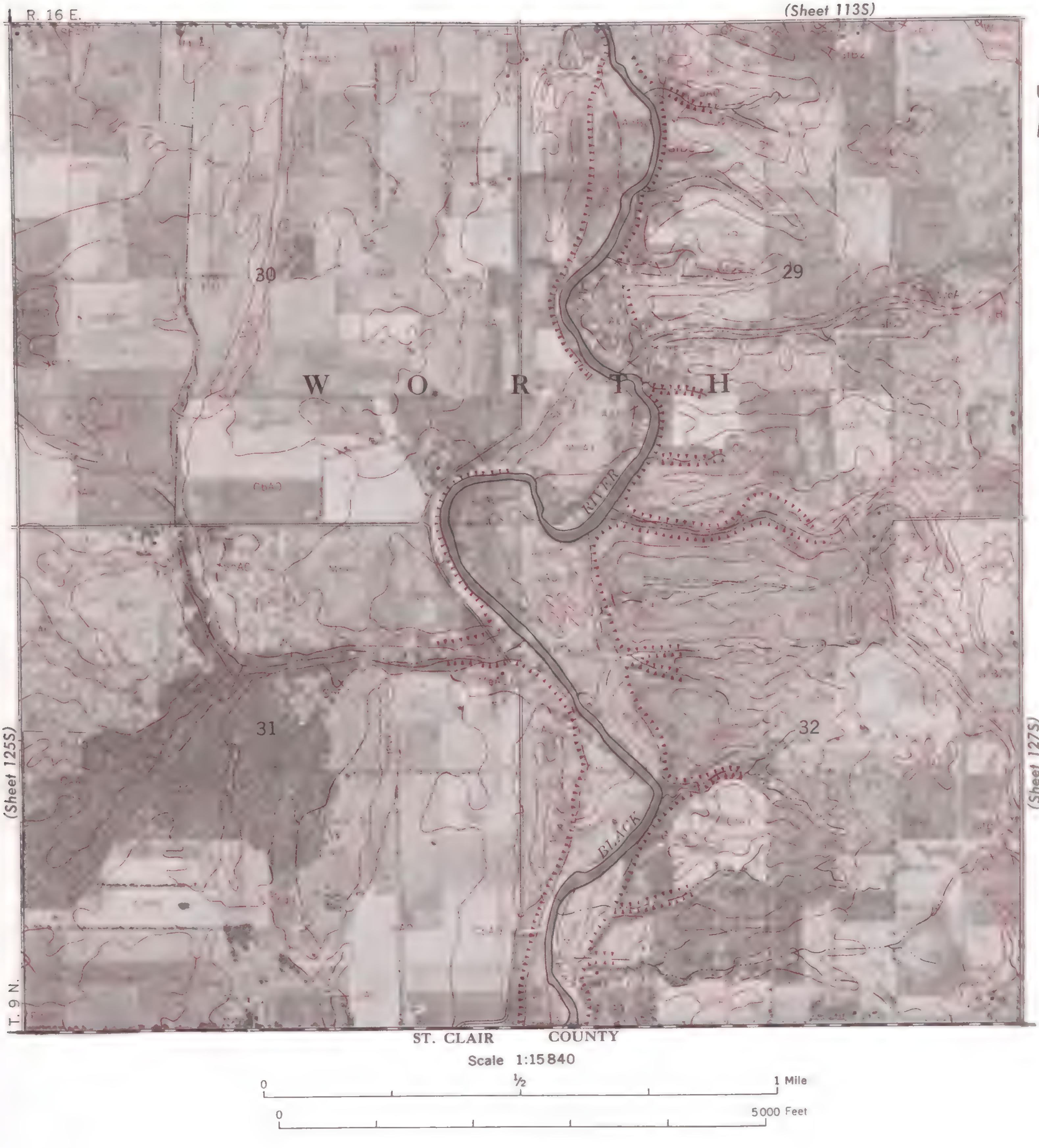

R. 16 E.
N
L A K E
H U R O N
26
35
S A N I L A C
PORT SANILAC
(Sheet 123N)
T. 12 N.
(Sheet 15S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 15 E.
(Sheet 111S)
Red School
N
28
27
F R E M O N T
33
34
(Sheet 123S)
(Sheet 125S)
T. 9 N.
ST. CLAIR COUNTY
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


R. 16 E.
(Sheet 113S)
N
30
29
W O R T H
RIVER
31
32
BLACK
(Sheet 125S)
(Sheet 127S)
T. 9 N.
ST. CLAIR COUNTY
Scale 1:15840
0
½
1 Mile
0
5000 Feet


(Sheet 114S)
R. 16 E.
Amadore
N
28
27
CHESAPEAKE AND OHIO
W O R T H
33
34
(Sheet 126S)
(Sheet 128S)
McIntyre School
Holiness Church
ST. CLAIR COUNTY
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


R. 17 E.
(Sheet 116S)
N
25
30
Amadore Beach
L A K E
W O R T H
H U R O N
Orchard Beach
Birch
31
Creek
(Sheet 128S)
25
ST. CLAIR COUNTY
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet
T. 9 N.

Scale 1:15840

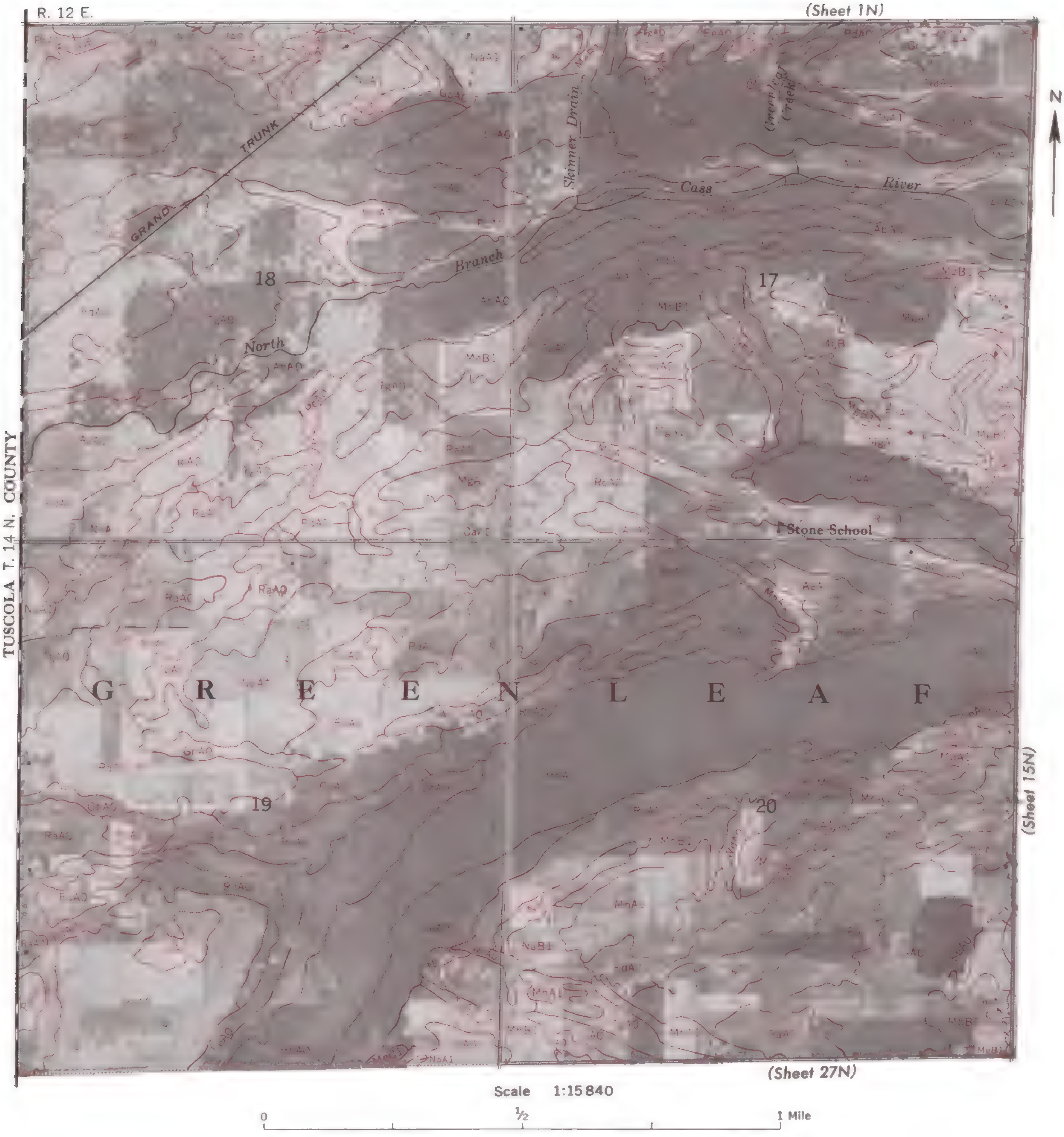
0 ½ 1 Mile

0 5000 Feet


(Sheet 121N)
R. 15 E.
T. 11 N.
N
GARSONVILLE
W A S H I N G T O N
2
1
11
12
(Sheet 11S)
(Sheet 13S)
(Sheet 27S)
CHESAPEAKE AND OHIO
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


HURON COUNTY
R. 16 E.
T. 14 N.
N
6
5
8
7
LAKE
HURON
D E L A W A R E
FORESTVILLE
Creek
(Sheet 12N)
(Sheet 26N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 16 E.
(Sheet 122N)
T. 11 N.
6
5
7
8
S A N I L A C
(Sheet 12S)
(Sheet 14S)
(Sheet 28S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet



Scale 1:15 840

0 ½ 1 Mile

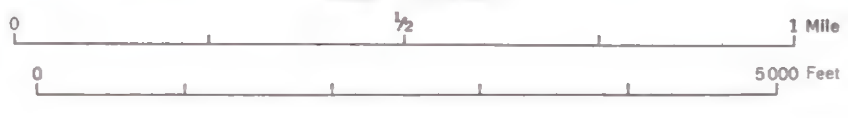
0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet

Scale 1:15840



Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet


(Sheet 3N)
R. 12 E.
N
South Fork
Cass River
Simpkins
Drain
14
13
23
24
T. 14 N.
G R E E N L E A F
(Sheet 15N)
(Sheet 17N)
(Sheet 29N)
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

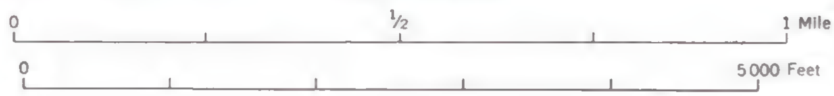
Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 3S)
R. 12 E.
Germania Corners
N
14
13
M A R L E T T E
T. 11 N.
23
24
(Sheet 17S)
(Sheet 19S)
(Sheet 33S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

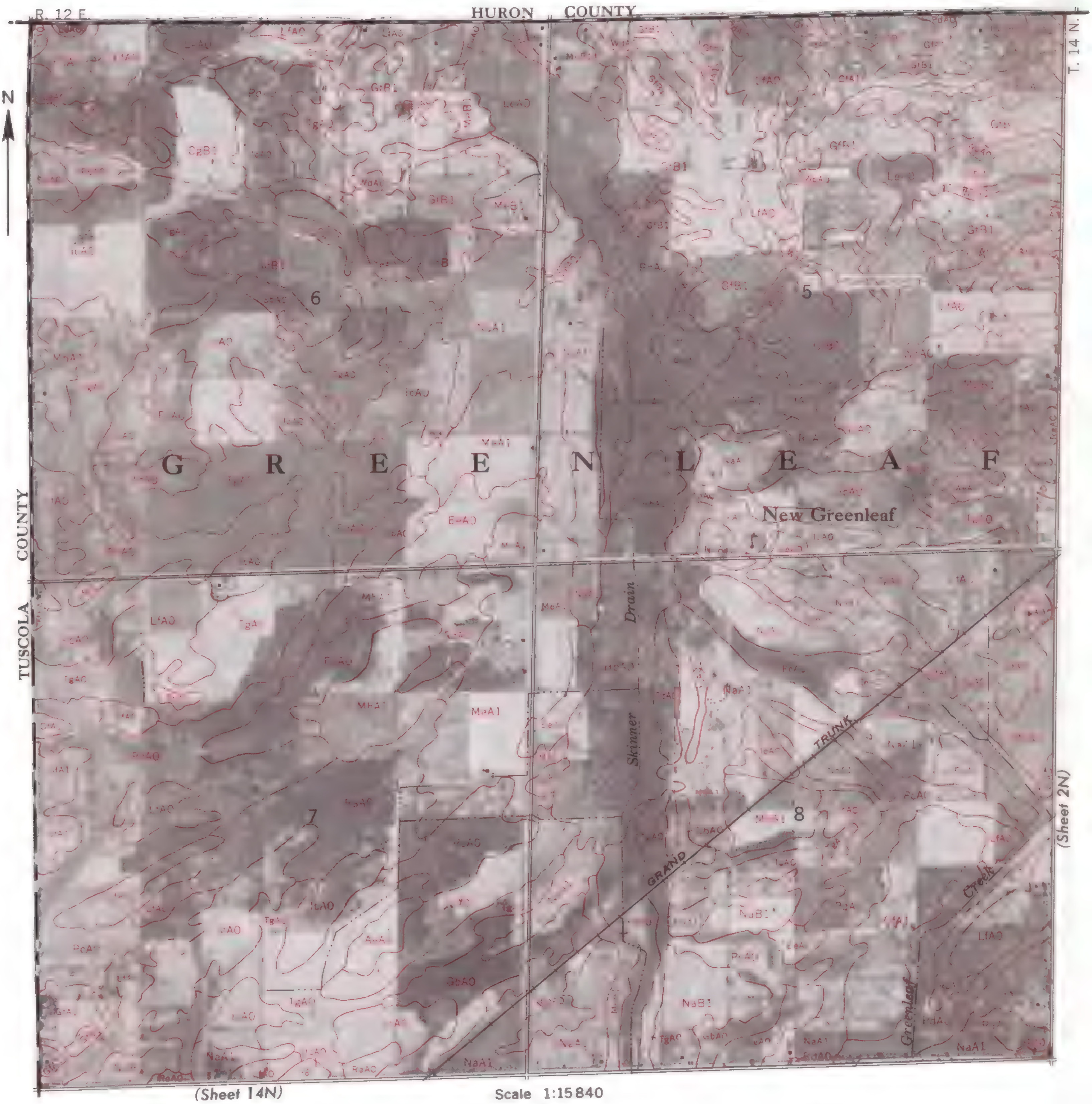
Scale 1:15 840



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15840

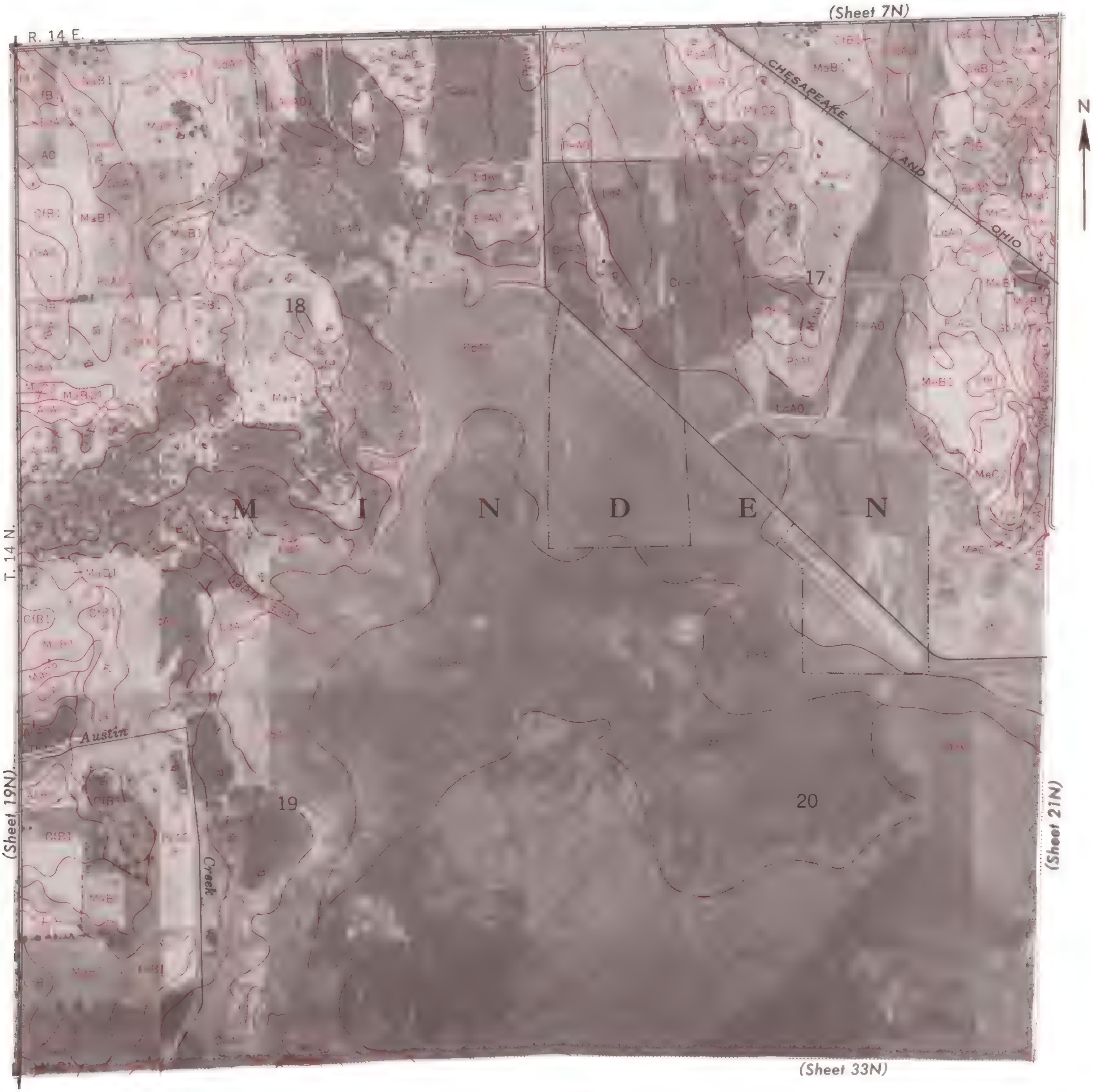
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet

21N

SANILAC COUNTY. MICHIGAN

all 13 acres

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

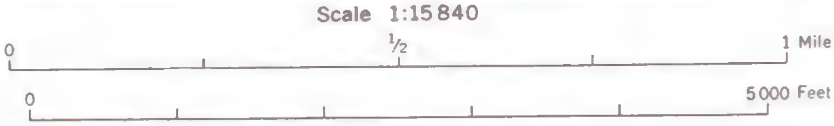

N
(Sheet 6S)
R. 13 E.
T. 11 N.
(Sheet 20S)
(Sheet 22S)
(Sheet 36S)
14
13
23
24
E L M E R
Elmer Church
PdAO
CbAO
CaAO
CaB1
JaAO
SbAC
TeAO
MhB1
MgA1
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

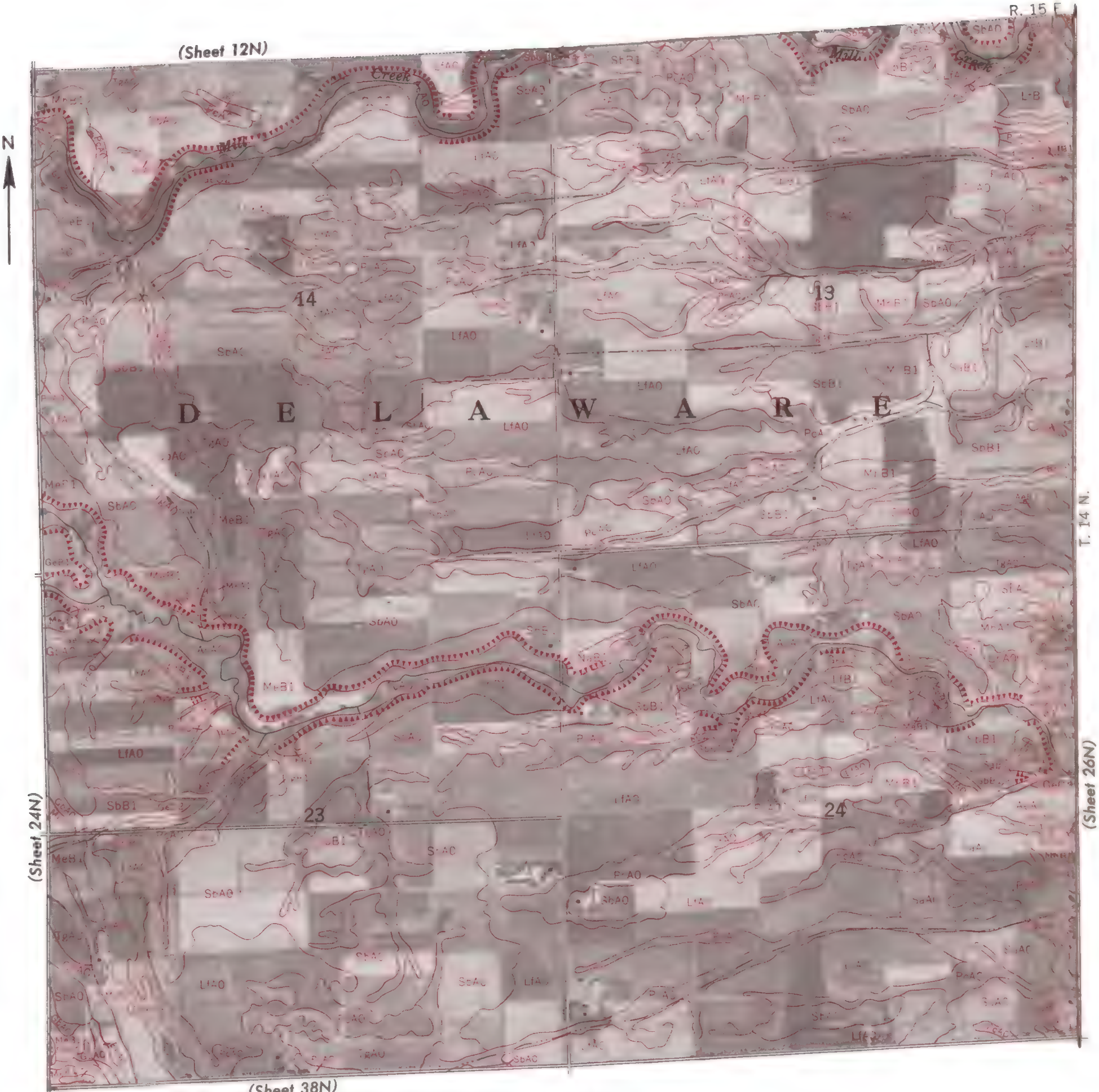
0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

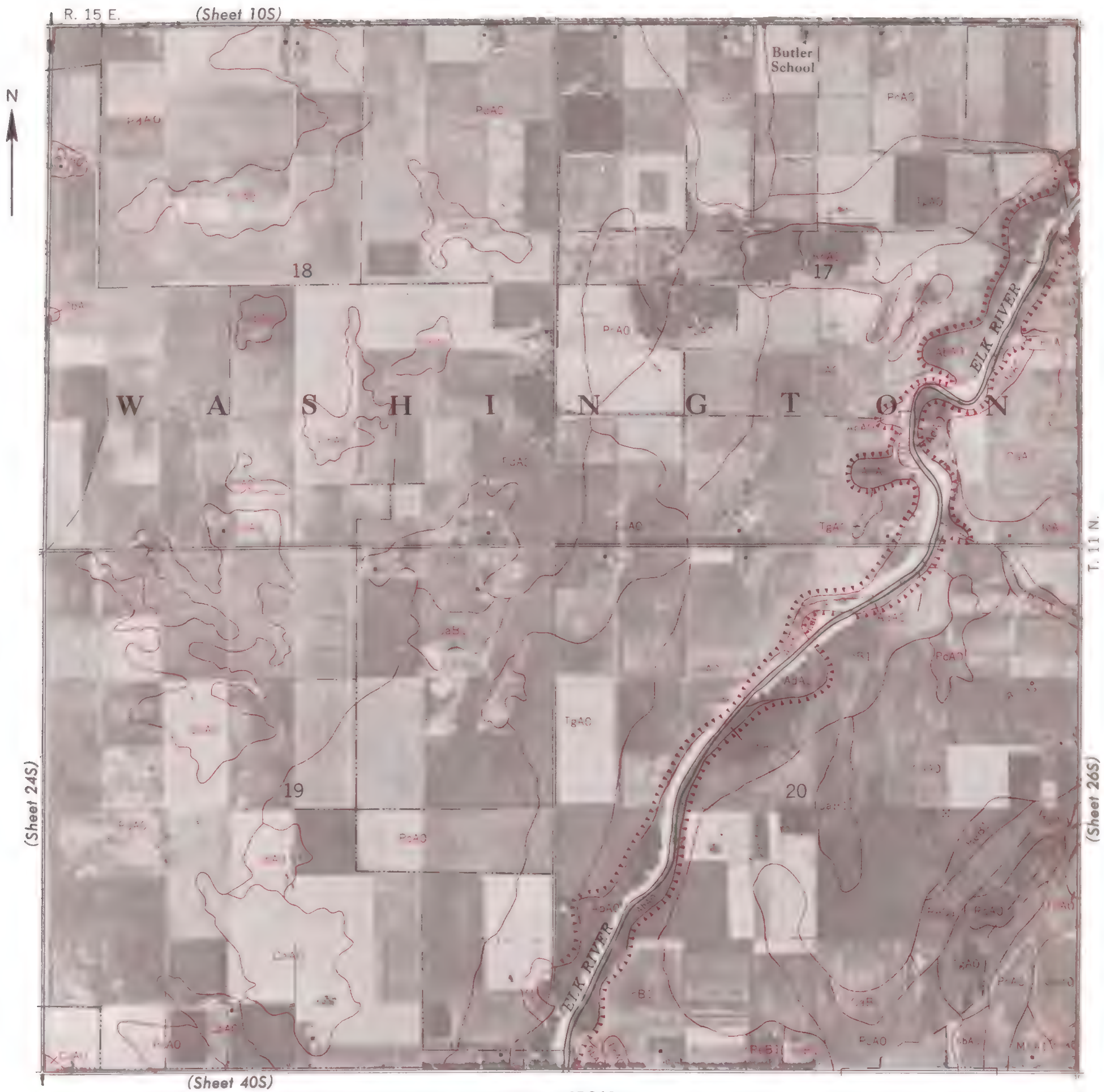
0 5000 Feet



Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

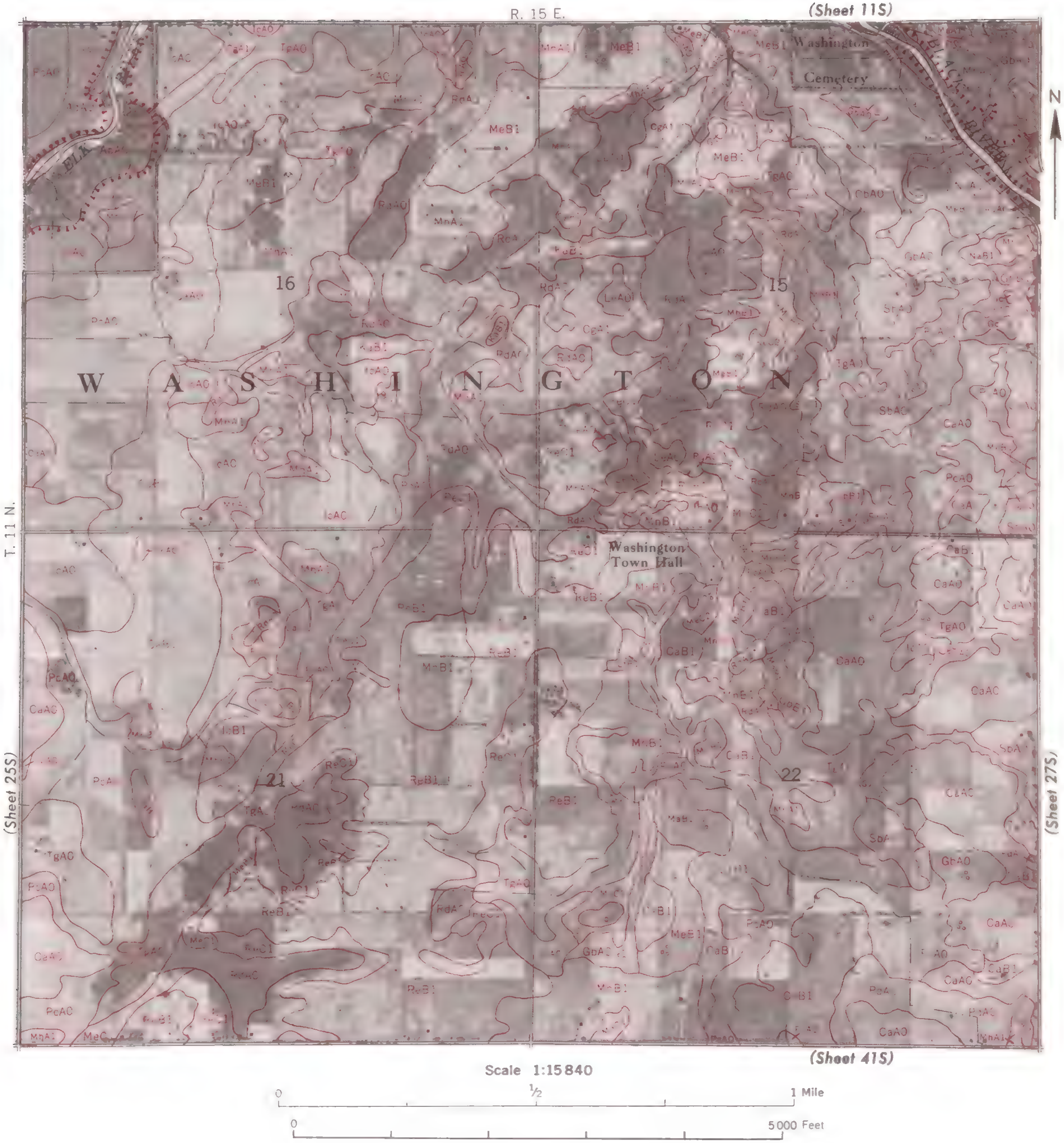


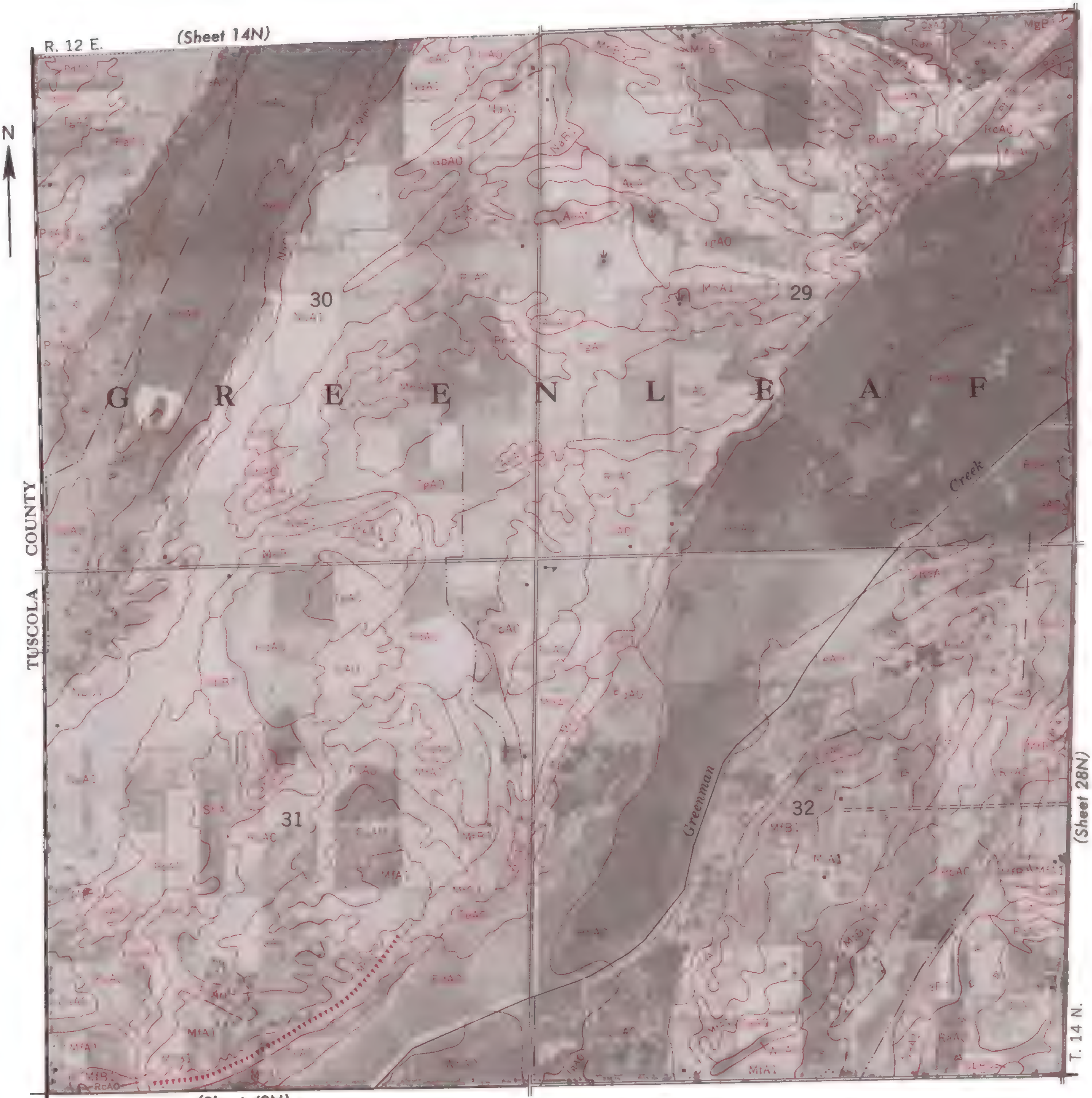
Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


R. 16 E.
(Sheet 13N)
N
Mill
Creek
F O R E S T V I L L E
18
17
T. 14 N.
25
D E L A W A R E
19
20
(Sheet 25N)
L A K E H U R O N
(Sheet 39N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 15 E.
(Sheet 11S)
T. 11 N.
(Sheet 25S)
(Sheet 27S)
(Sheet 41S)
N
W A S H I N G T O N
16
15
21
22
Washington Cemetery
Washington Town Hall
Scale 1:15840
0
½
1 Mile
0
5000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 — 1/2 — 1 Mile

0 — 5000 Feet


(Sheet 15N)
R. 12 E.
N
Greenman
Creek
28
27
G R E E N L E A F
Drain
33
34
(Sheet 27N)
(Sheet 29N)
T. 14 N.
(Sheet 41N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

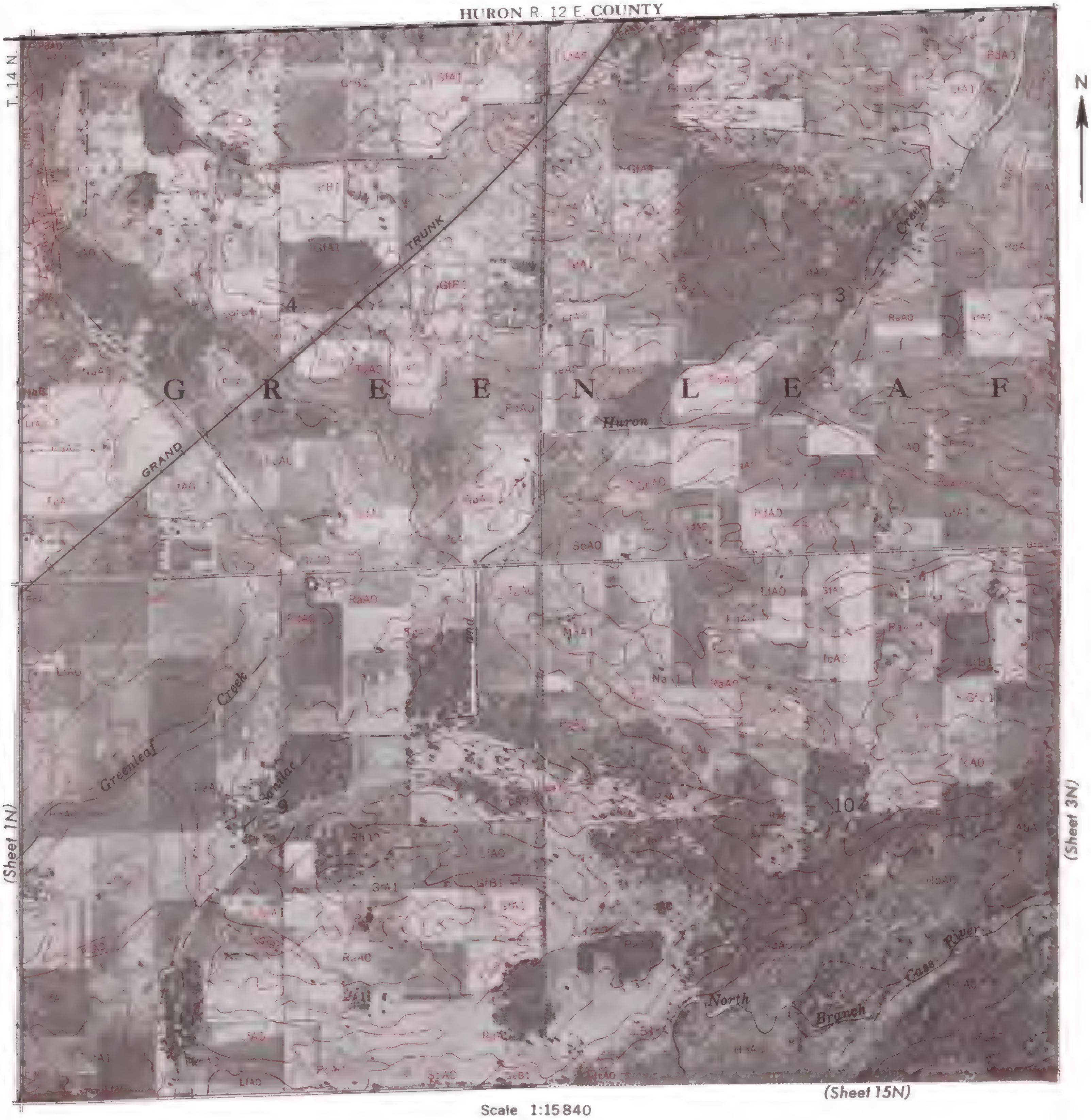

R. 16 E.
(Sheet 13S)
N
T. 11 N.
18
17
S A N I L A C
19
20
(Sheet 27S)
(Sheet 29S)
(Sheet 43S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 14S)
R. 16 E.
N
McKenzie Creek
16
15
S A N I L A C
T. 11 N.
(Sheet 28S)
(Sheet 30S)
21
22
(Sheet 44S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 15S)
R. 16 E.
N
L A K E
H U R O N
S A N I L A C
Camp Ozanam
Lafayette
Heights
14
23
T. 11 N.
(Sheet 29S)
(Sheet 45S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 13 E.
(Sheet 18N)
N
28
27
A U S T I N
Hobbs Drain
Franzel Drain
33
34
(Sheet 30N)
(Sheet 32N)
T. 14 N.
(Sheet 44N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

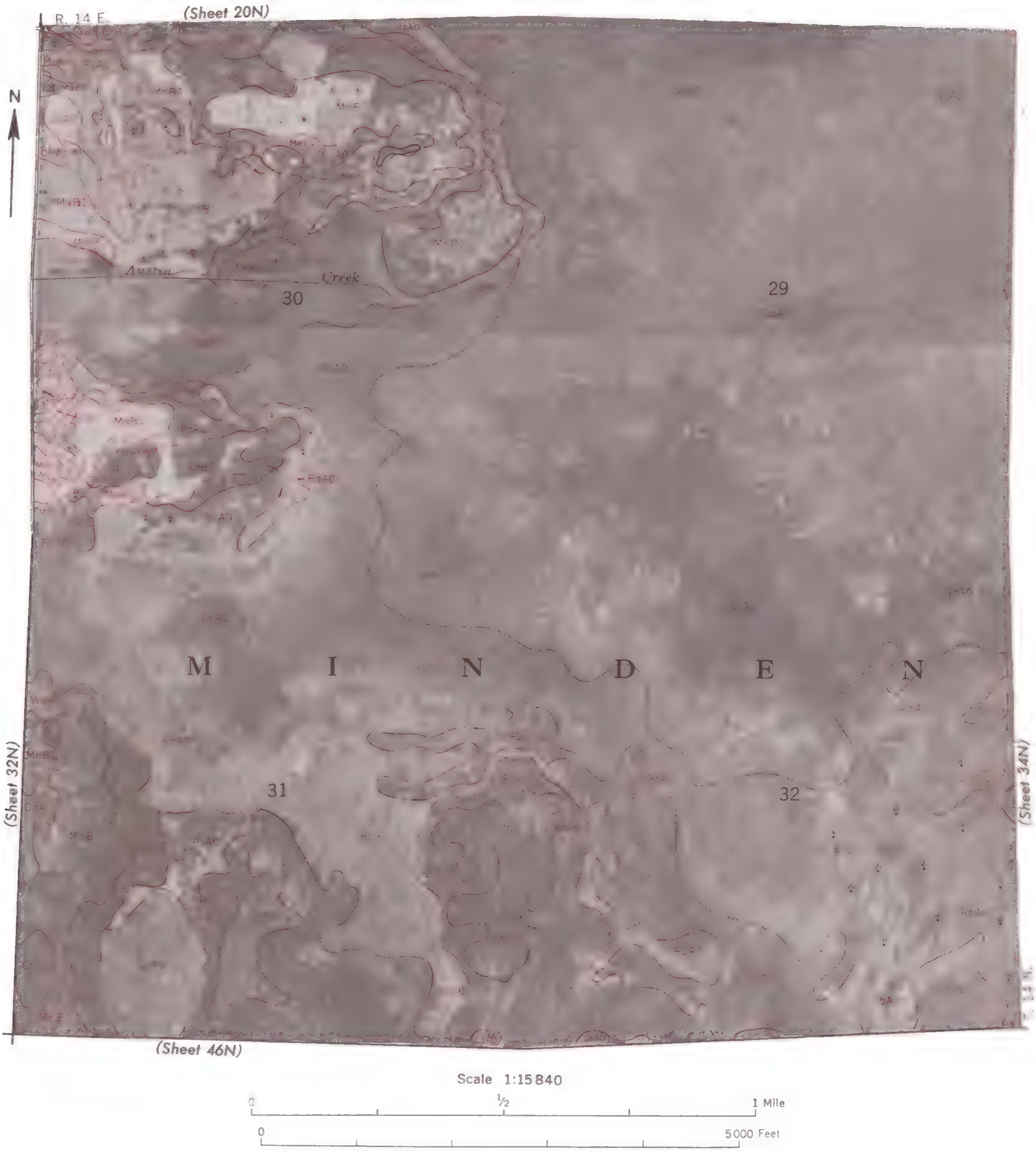
0 5000 Feet


(Sheet 19N)
R. 13 E.
N
Frieberg
Flannery
Drain
Austin
Creek
A U S T I N
26
25
35
36
Franzel
Drain
(Sheet 31N)
(Sheet 33N)
(Sheet 45N)
T. 14 N.
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

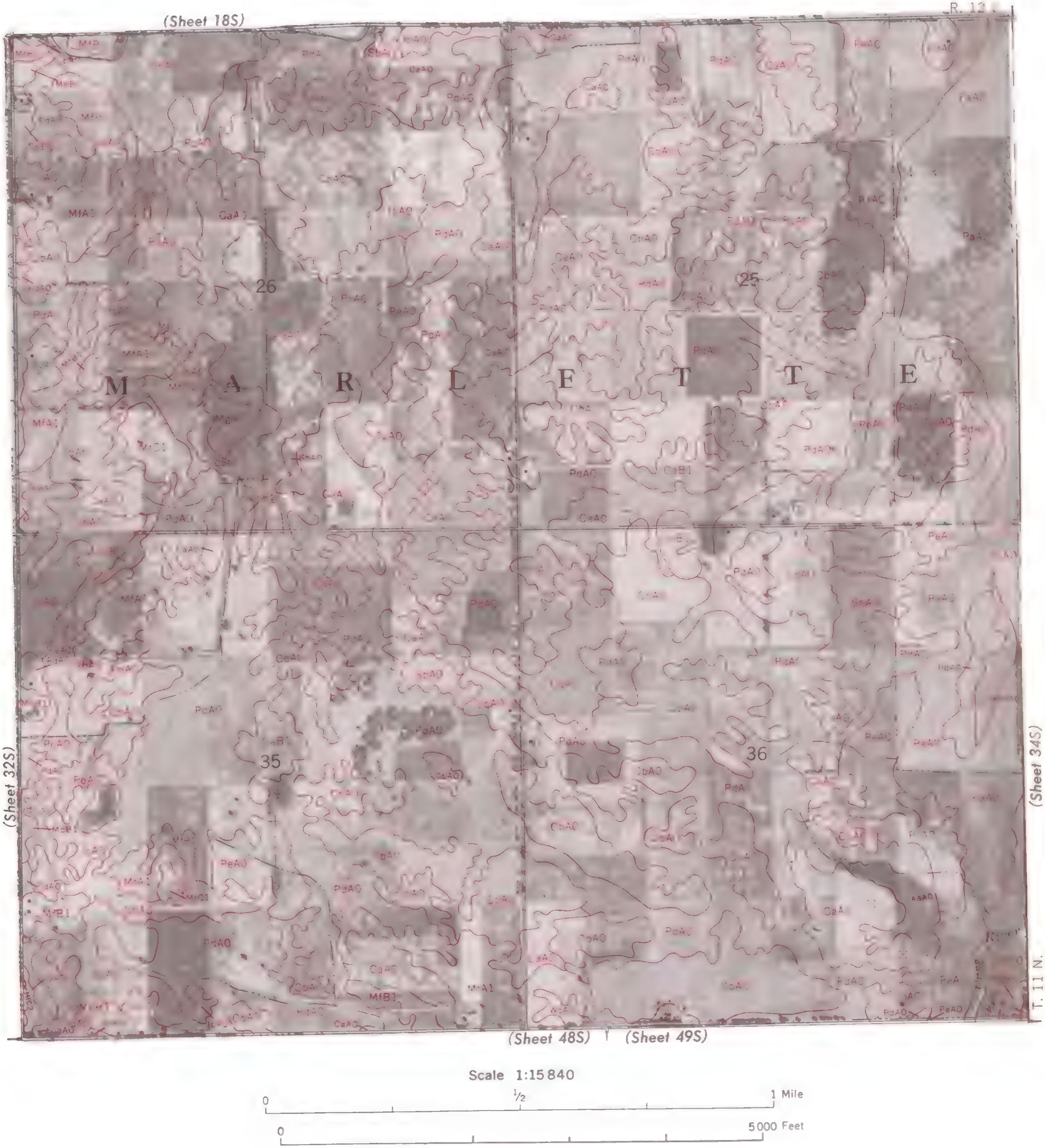
Scale 1:15840

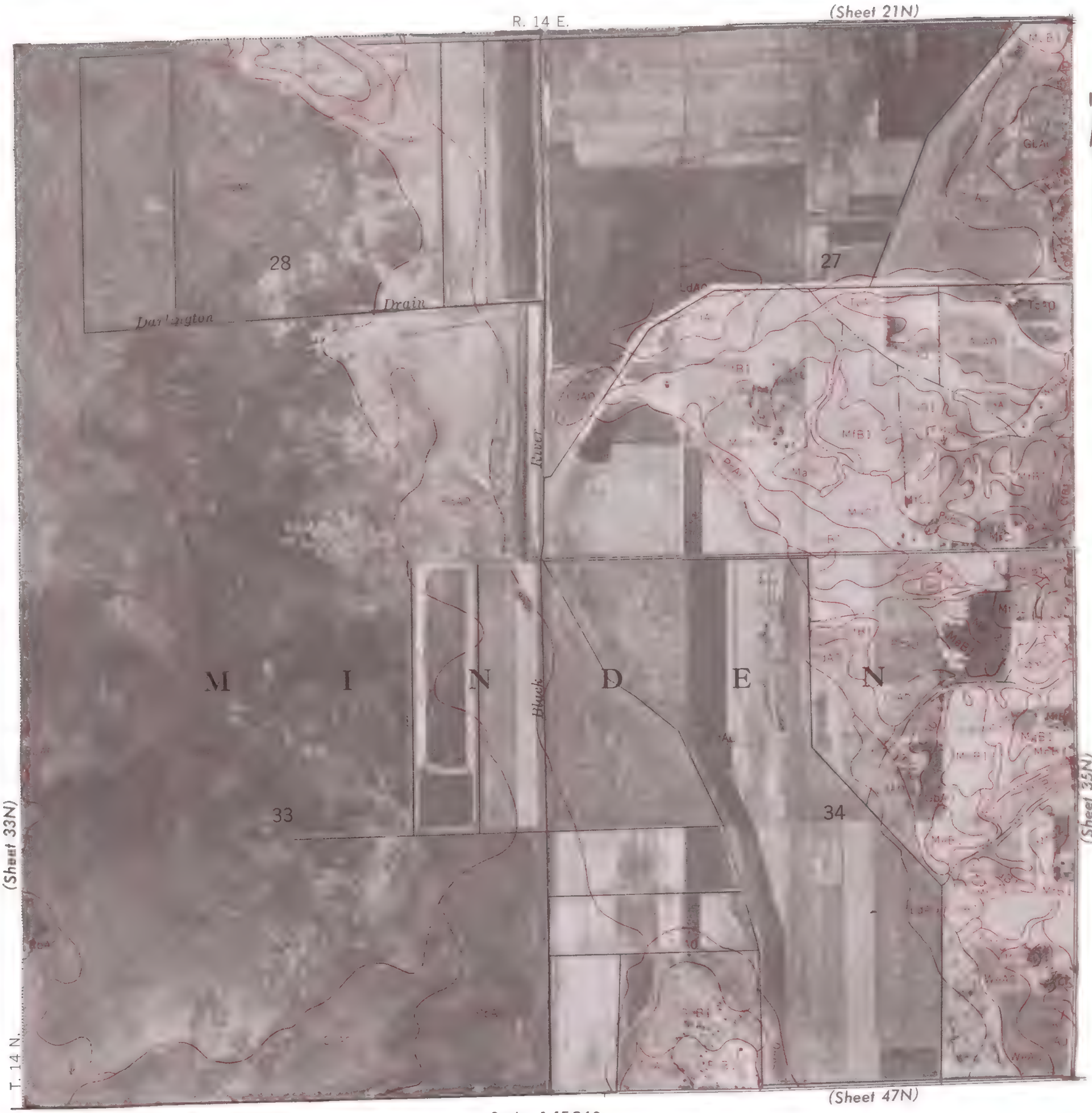
0 ½ 1 Mile

0 5000 Feet


R. 14 E.
(Sheet 20N)
N
Austin Creek
30
29
M I N D E N
31
32
(Sheet 32N)
(Sheet 34N)
(Sheet 46N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

SANILAC COUNTY, MICHIGAN

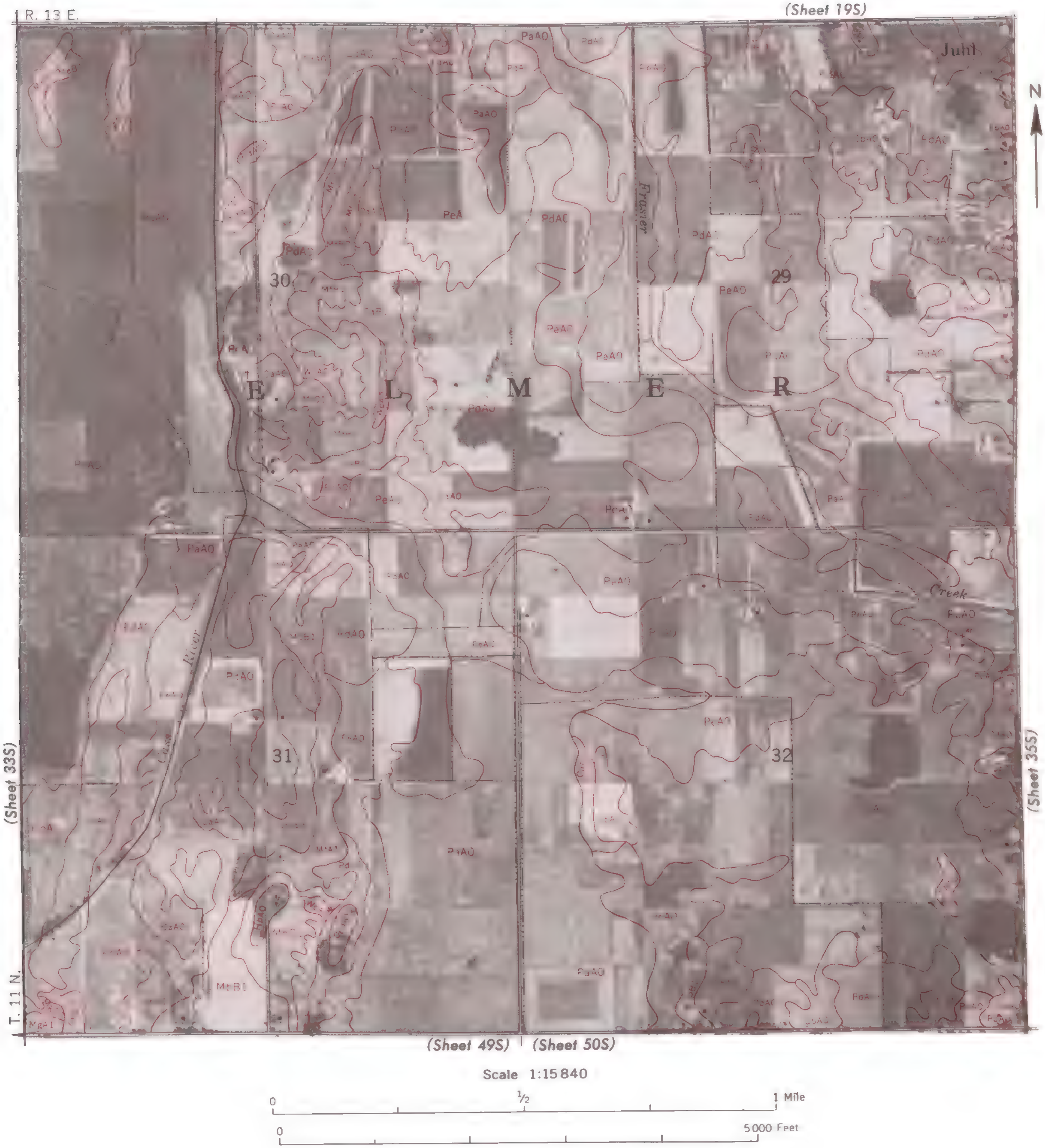




Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

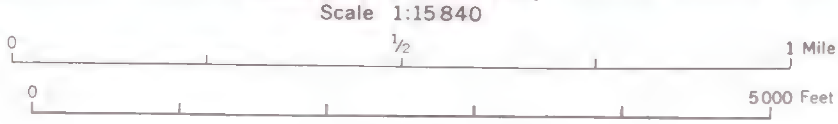

R. 13 E.
(Sheet 19S)
Juhl
N
Frasier
30
29
E L M E R
Creek
River
31
32
(Sheet 33S)
(Sheet 35S)
T. 11 N.
PaAO
PdAO
PeA
PeAO
MrB1
(Sheet 49S)
(Sheet 50S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 1/2 1 Mile

0 5000 Feet

Scale 1:15840



Scale 1:15840

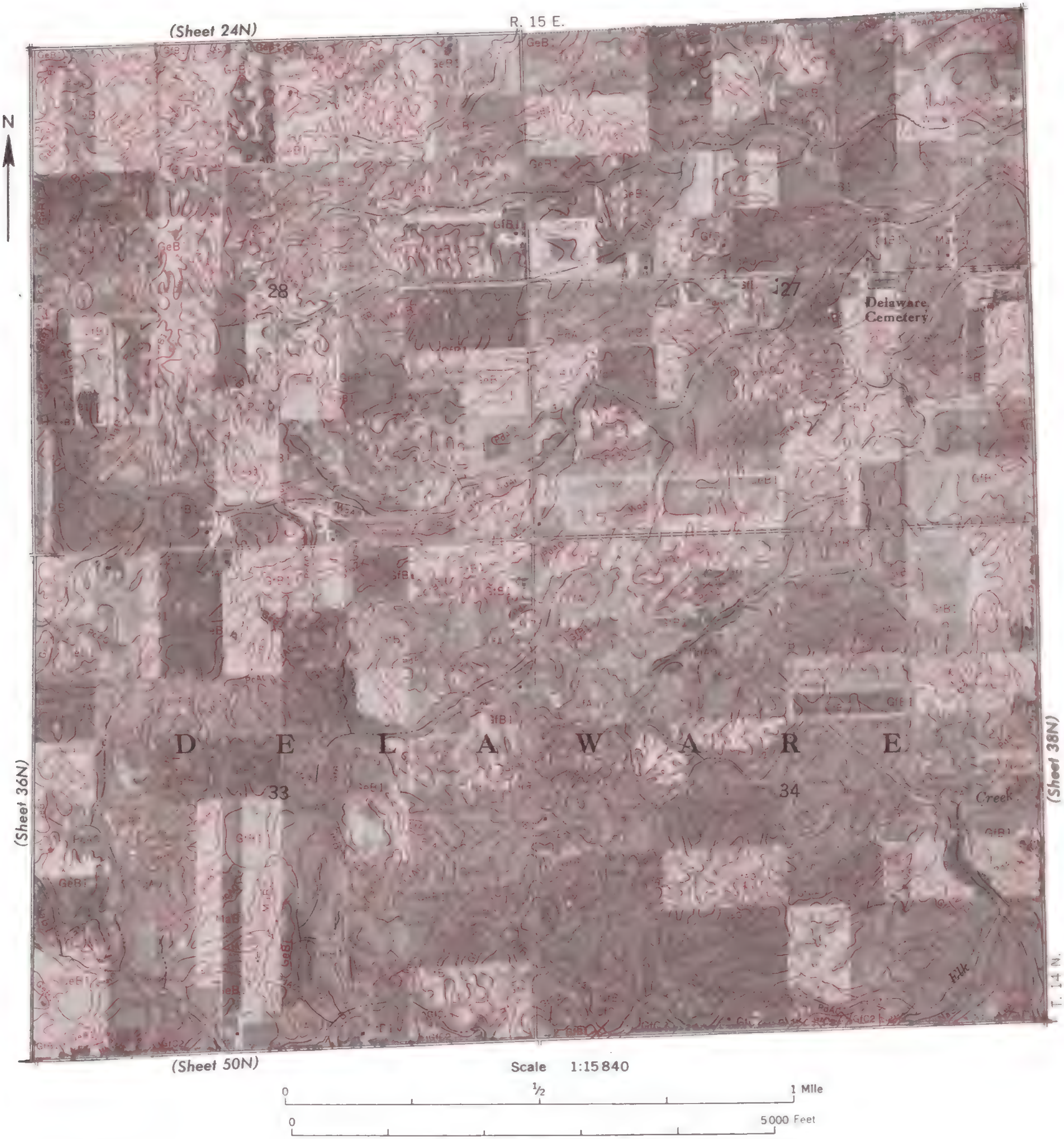
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 1/2 1 Mile

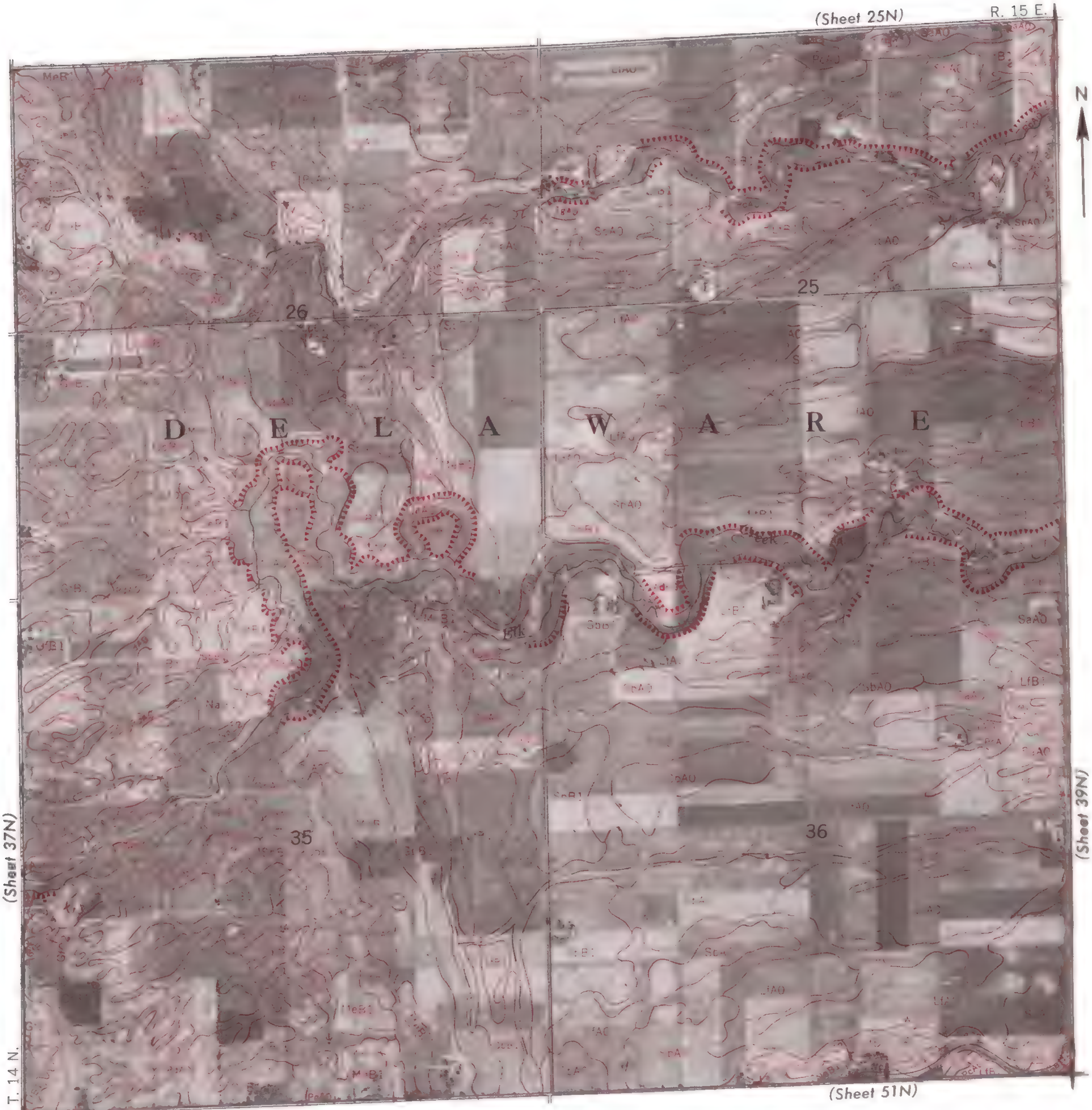
0 5000 Feet


R. 15 E.
(Sheet 24N)
N
28
27
Delaware Cemetery
D E L A W A R E
33
34
Creek
Elk
(Sheet 36N)
(Sheet 38N)
T. 14 N.
(Sheet 50N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

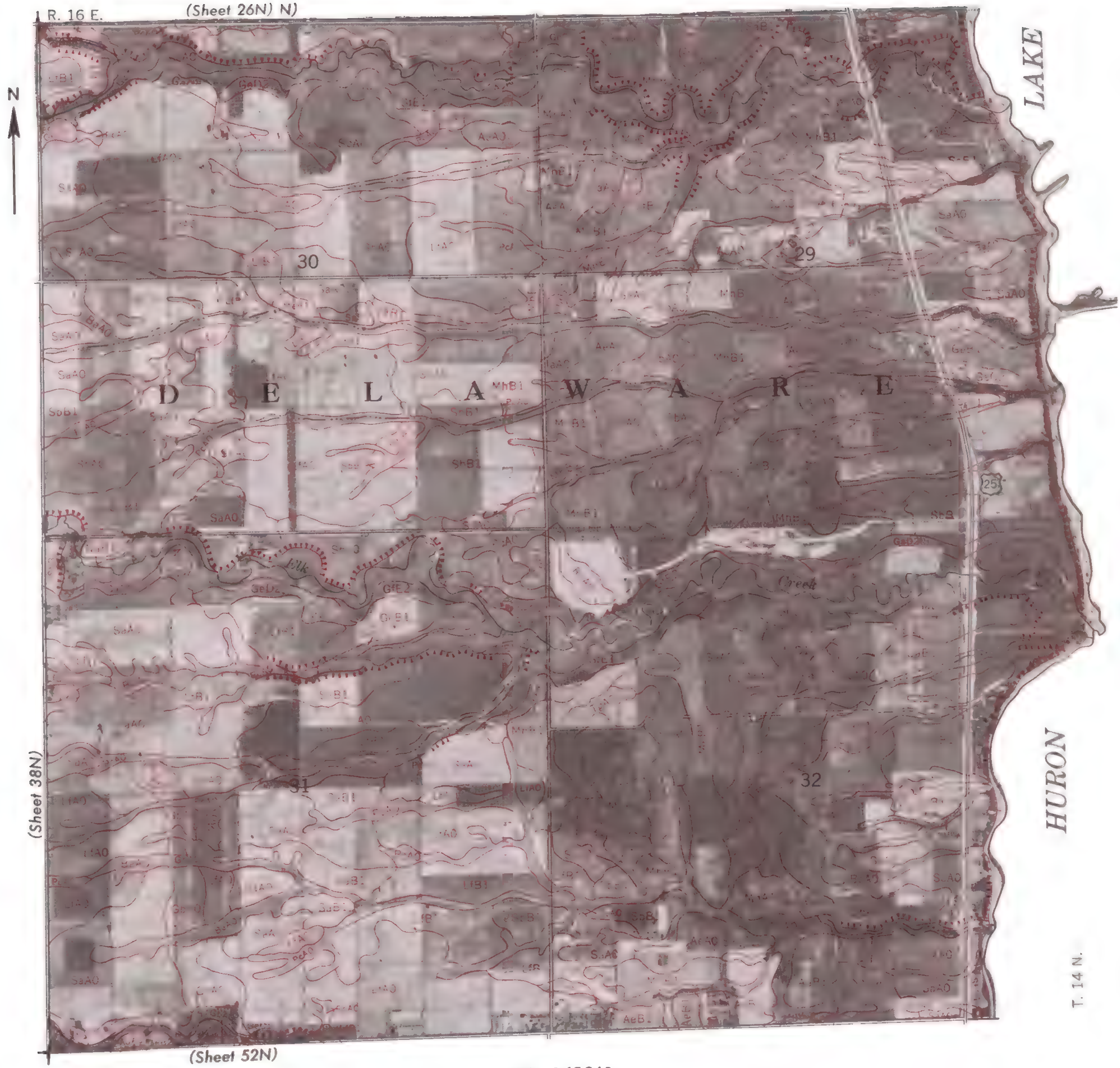


Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

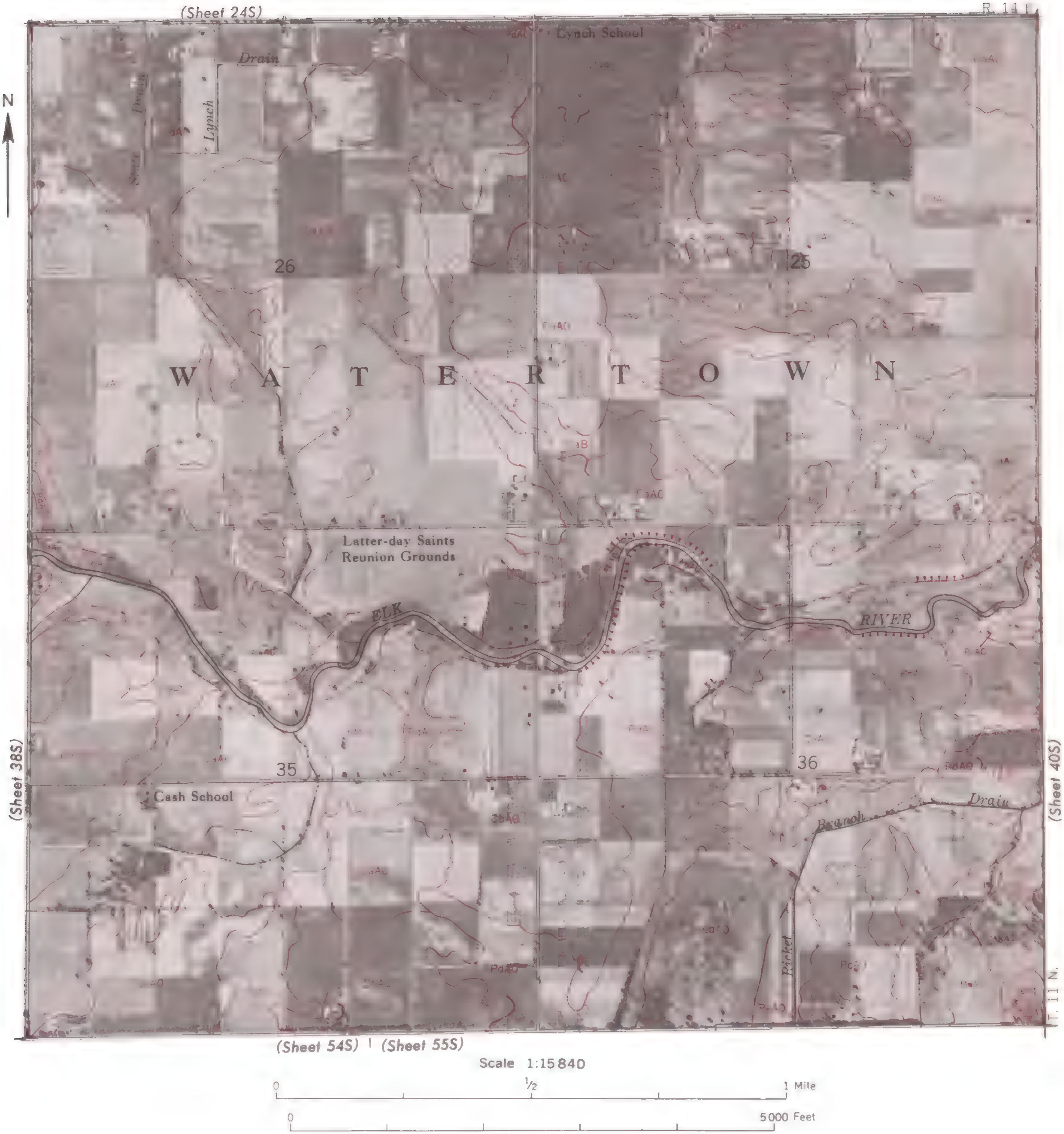

R. 14 E.
(Sheet 23S)
N
W A T E R T O W N
28
27
33
34
Smaldon Drain
ELK RIVER
Cash
Church of God
Zion Cemetery
(Sheet 37S)
(Sheet 39S)
T. 11 N.
(Sheet 53S)
(Sheet 54S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet



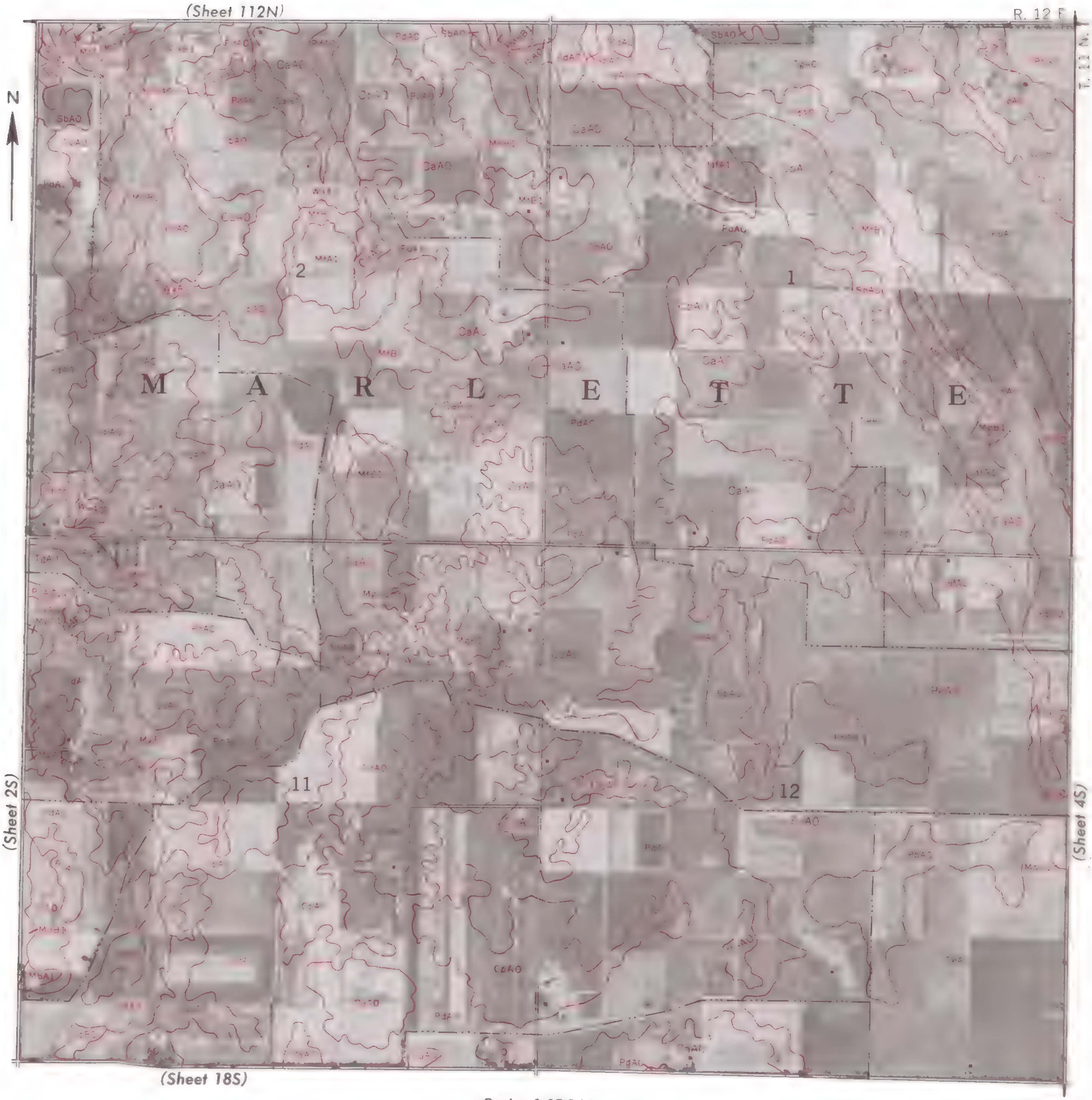
Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet


(Sheet 24S)
R. 14 E.
N
Lynch School
Drain
Lynch
26
25
W A T E R T O W N
Latter-day Saints
Reunion Grounds
ELK
RIVER
35
36
Cash School
Drain
Branch
Ricket
(Sheet 38S)
(Sheet 40S)
T. 11 N.
(Sheet 54S)
(Sheet 55S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


HURON COUNTY
R. 12 E.
T. 14 N.
N
G R E E N L E A F
2
1
11
12
Branch
Cass
River
North
Fork
Cass
South
River
Holbrook Church
(Sheet 2N)
(Sheet 4N)
(Sheet 16N)
Scale 1:15840
0
½
1 Mile
0
5000 Feet



Scale 1:15840

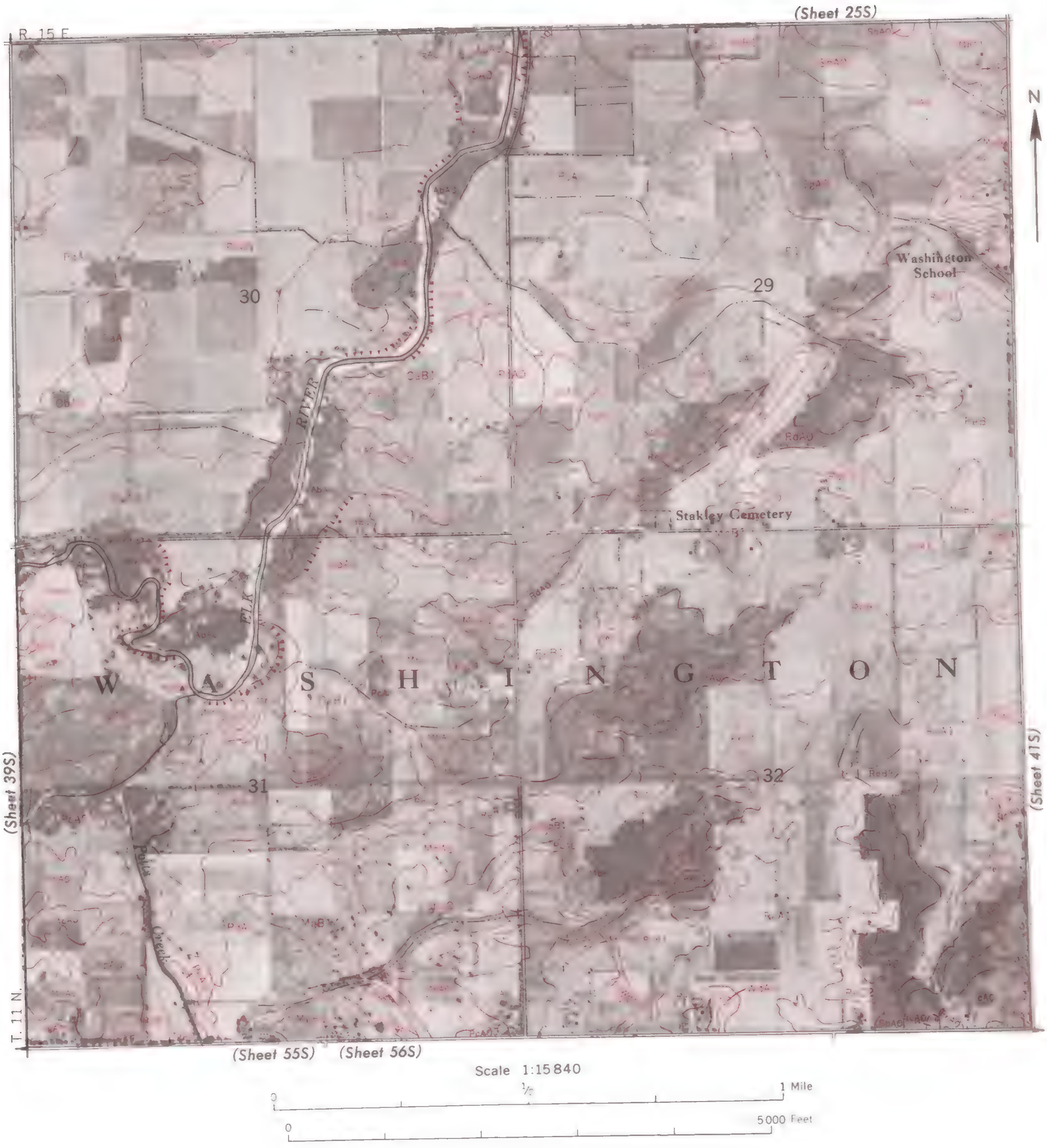
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 25S)
R. 15 E.
N
30
29
Washington School
ELK RIVER
Stakley Cemetery
W A S H I N G T O N
31
32
(Sheet 39S)
(Sheet 41S)
T. 11 N.
Pola Creek
(Sheet 55S)
(Sheet 56S)
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet


R. 12 E.
(Sheet 28N)
T. 13 N.
N
4
3
E V E R G R E E N
9
10
(Sheet 40N)
(Sheet 42N)
(Sheet 55N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

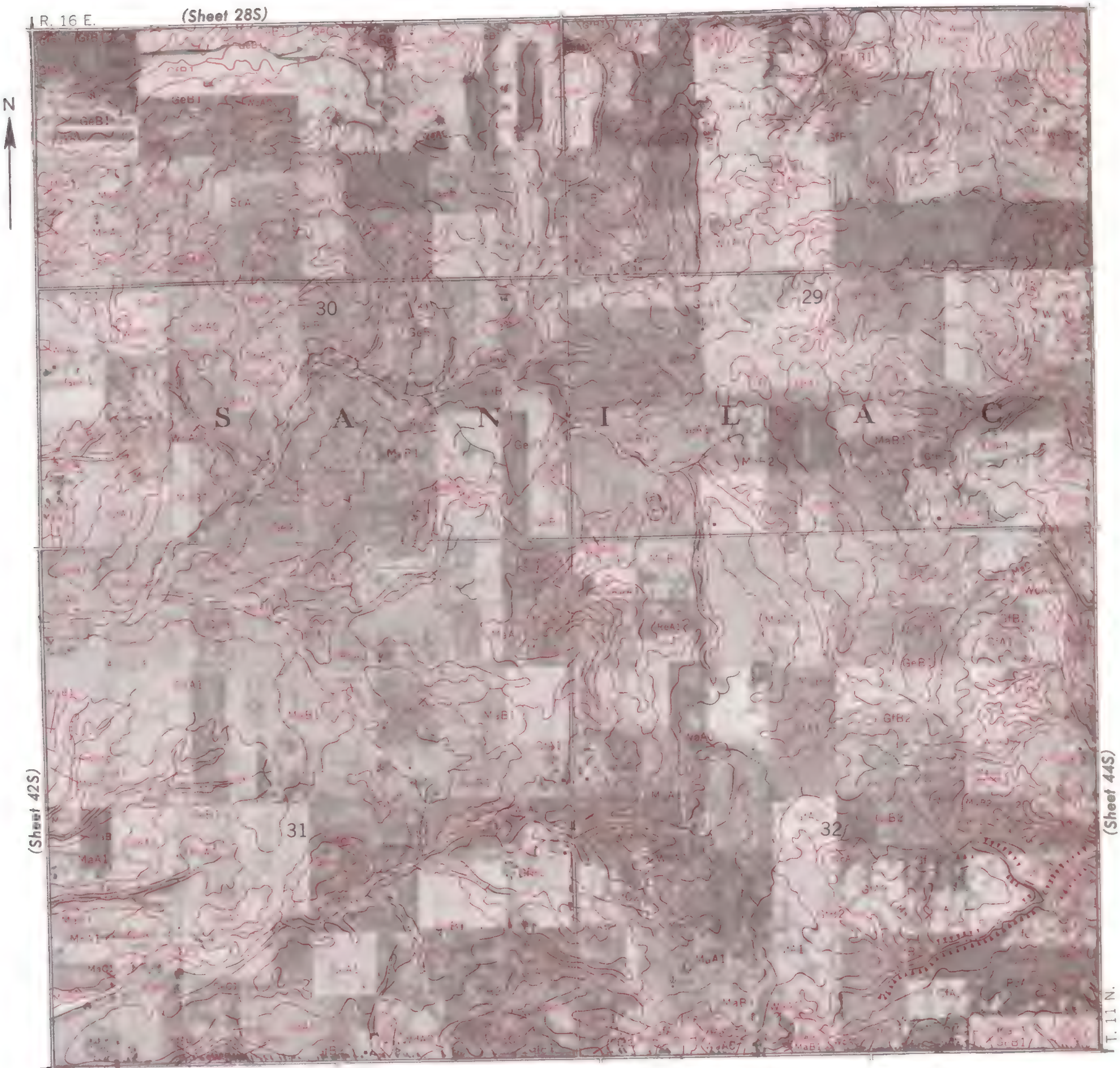
0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


R. 13 E.
(Sheet 30N)
T. 13 N.
N
(Sheet 42N)
(Sheet 44N)
(Sheet 57N)
A R G Y L E
Branch
Ingles
Starr School
6
5
7
8
Scale 1:15 840
0
½
1 Mile
0
5000 Feet



Scale 1:15 840

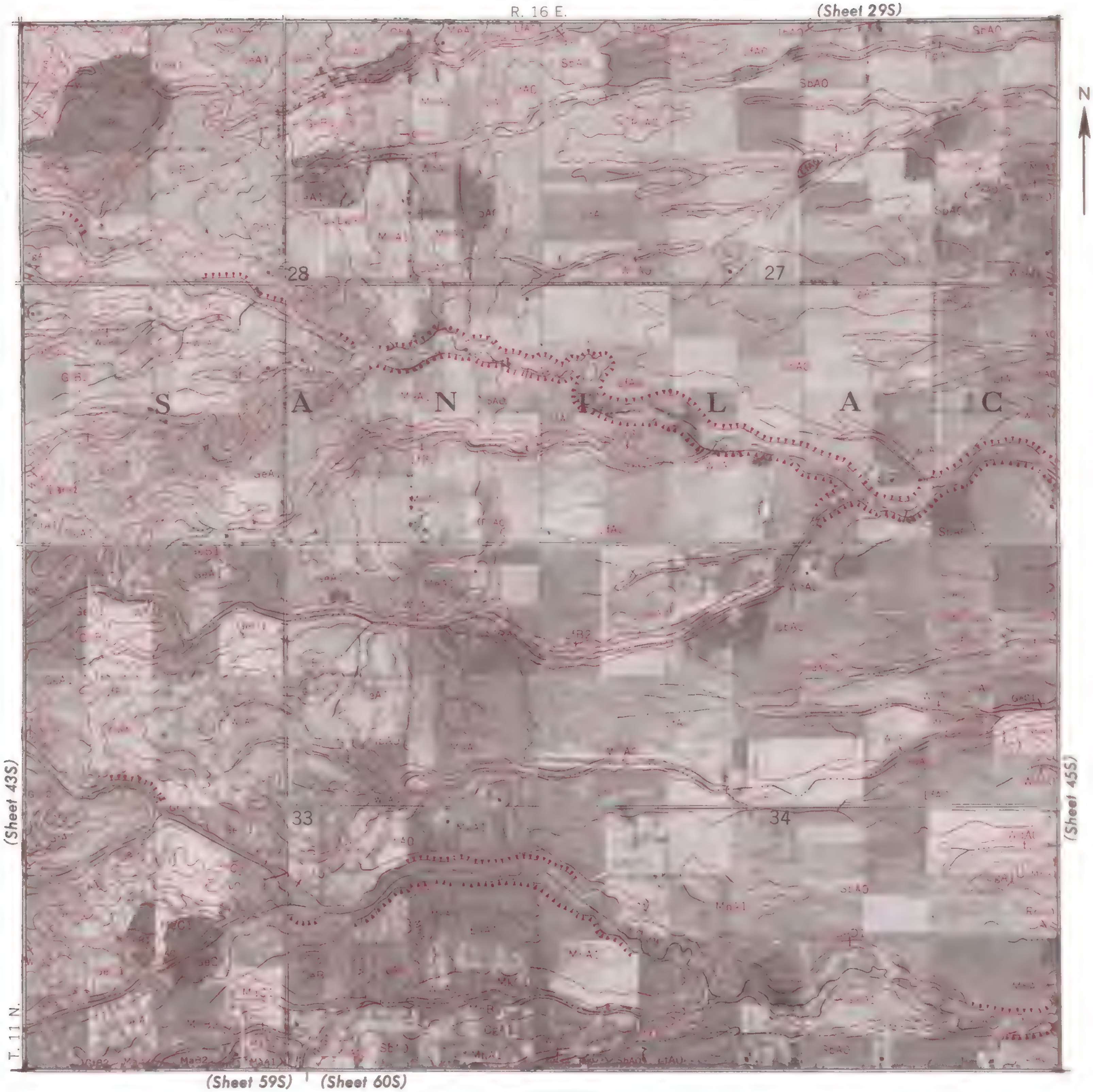
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15 840

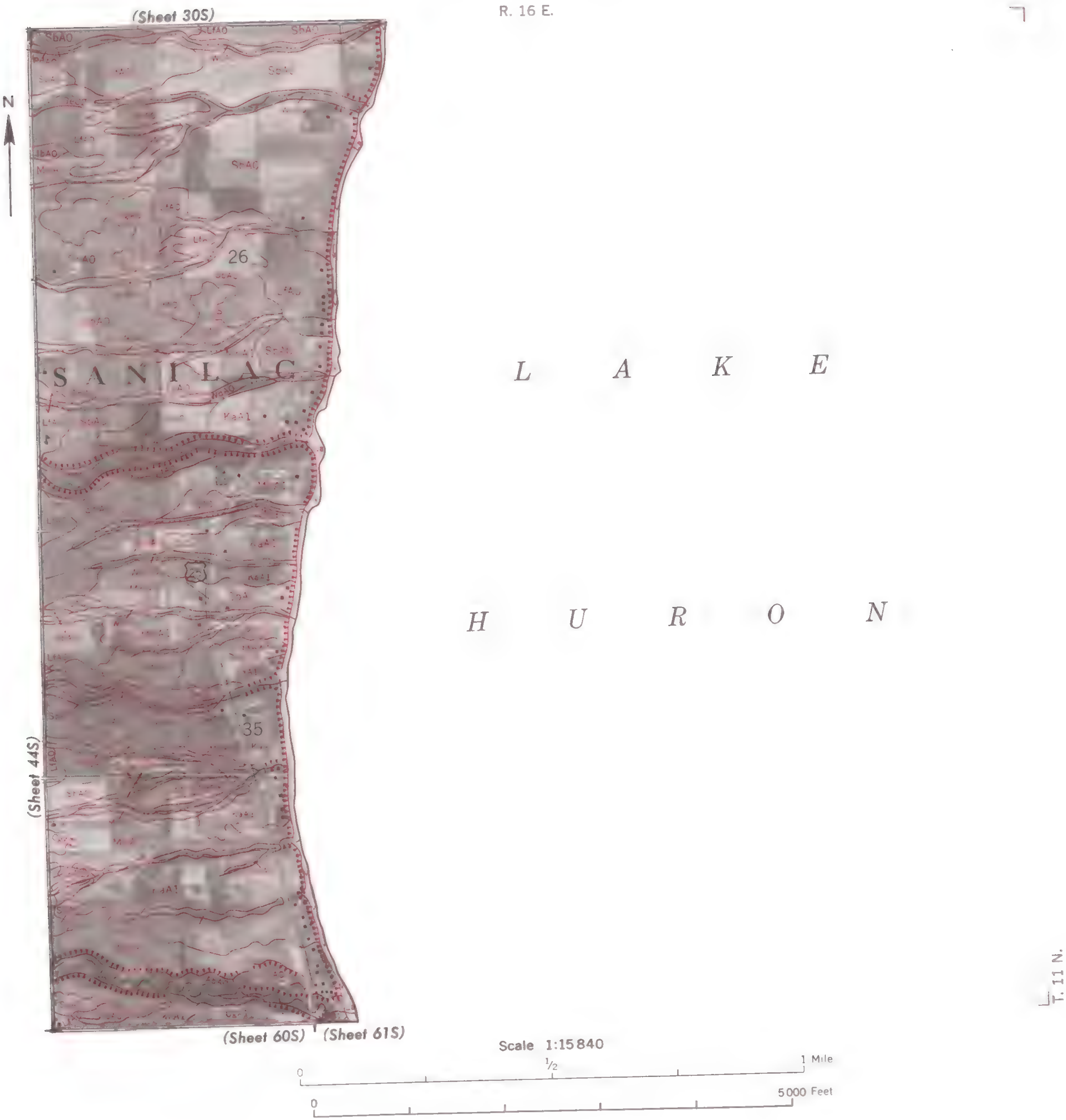
0 ½ 1 Mile

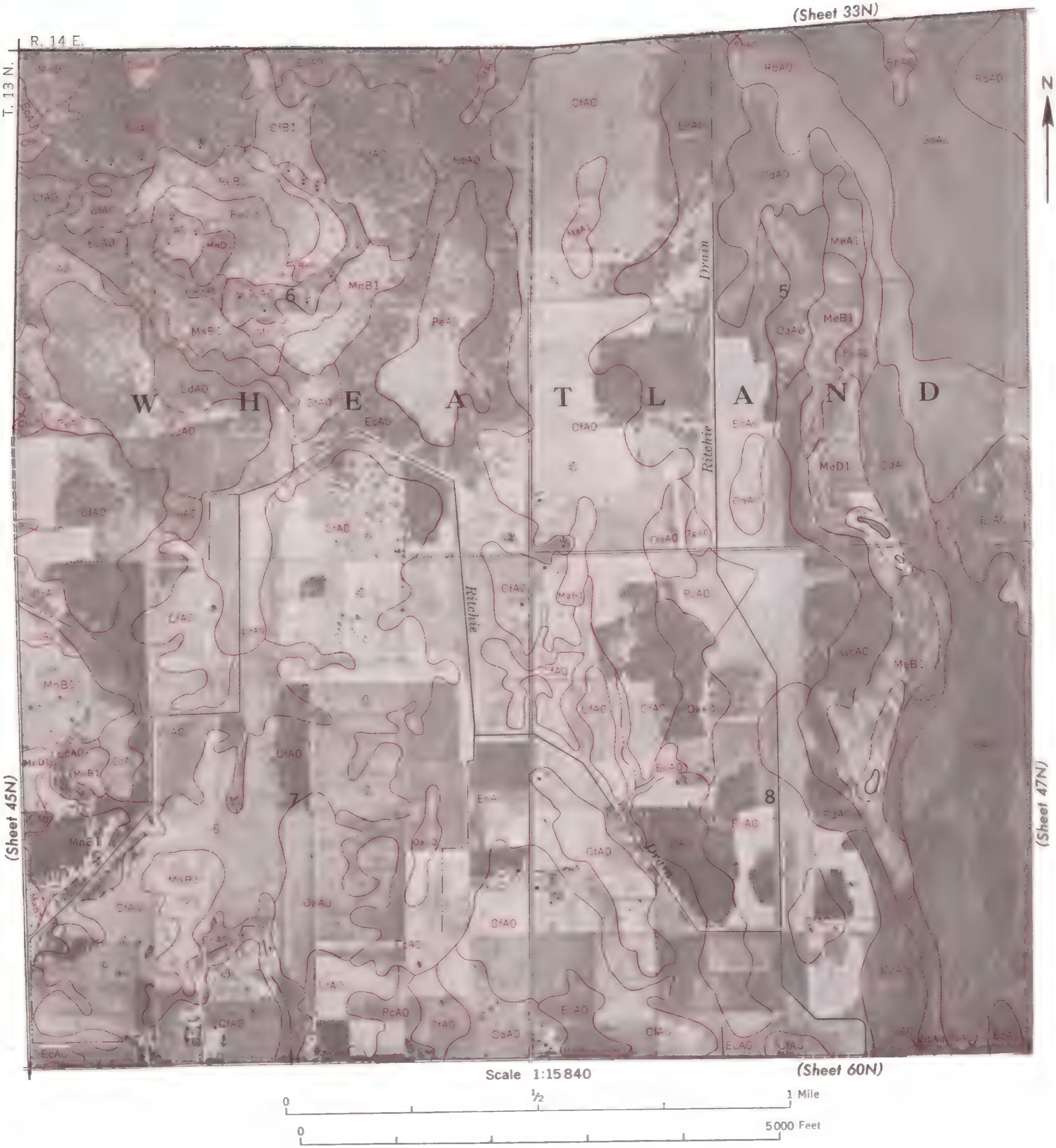
0 5000 Feet

Scale 1:15 840

0 1/2 1 Mile

0 5000 Feet


(Sheet 30S)
R. 16 E.
N
26
SANILAC
L A K E
H U R O N
35
(Sheet 44S)
(Sheet 60S)
(Sheet 61S)
T. 11 N.
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


(Sheet 33N)
R. 14 E.
T. 13 N.
W H E A T L A N D
Ritchie
Drain
(Sheet 45N)
(Sheet 47N)
(Sheet 60N)
N
CfAO
CfB1
RbAO
MeB1
MeD1
MnB1
PeA
EcAO
OaAO
PcAO
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 34N)
R. 14 E.
T. 13 N.
N
Black River
McManus Drain
4
3
W H E A T L A N D
9
10
Black River
(Sheet 46N)
(Sheet 48N)
(Sheet 61N)
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet


(Sheet 31S)
(Sheet 32S)
R. 12 E.
N
MARLETTE
M A R L E T T E
CHESAPEAKE AND OHIO
4
3
9
10
(Sheet 46S)
(Sheet 48S)
(Sheet 63S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 32S)
(Sheet 33S)
R. 12 E.
T. 10 N.
N
M A R L E T T E
1
2
11
12
Cass River
(Sheet 47S)
(Sheet 49S)
(Sheet 64S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

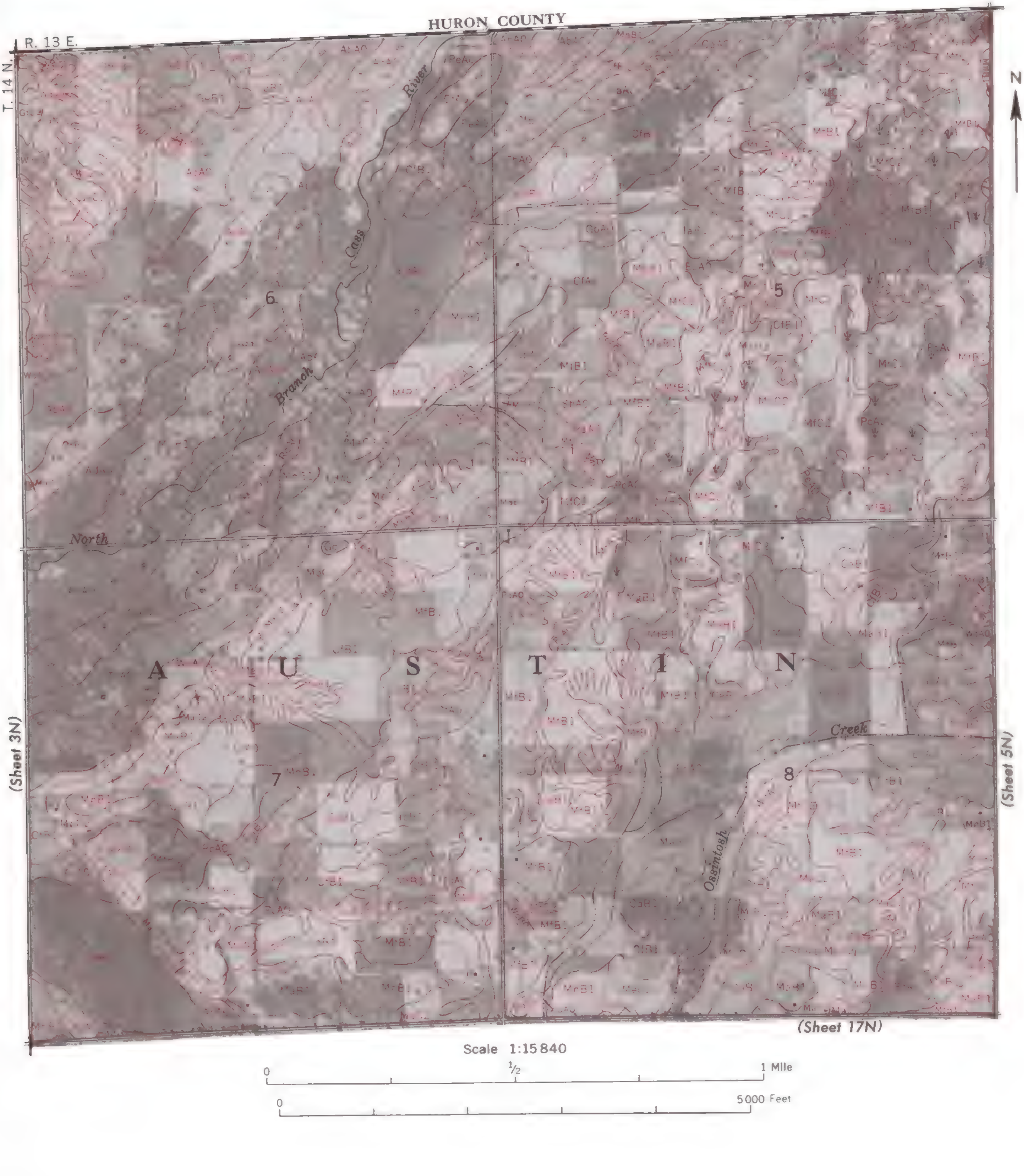

R. 15 E.
(Sheet 36N)
N
T. 13 N.
Creek
Elk
6
5
M A R I O N
Evans
Drain
Creek
7
8
Indian
Indian
(Sheet 48N)
(Sheet 50N)
(Sheet 63N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

SANILAC COUNTY, MICHIGAN

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


HURON COUNTY
R. 13 E.
T. 14 N.
N
Cass
River
Branch
North
6
5
7
8
A U S T I N
Creek
Ossintosh
(Sheet 3N)
(Sheet 5N)
(Sheet 17N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


R. 15 E.
(Sheet 37N)
T. 13 N.
N
M A R I O N
4
3
9
10
Creek
Elk
Mills School
Evans Drain
Indian
Creek
(Sheet 49N)
(Sheet 51N)
(Sheet 64N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


(Sheet 34S) R. 13 E. (Sheet 35S)
T. 10 N.
N
F L Y N N
4
3
9
10
Creek
Frasier
(Sheet 49S)
(Sheet 51S)
(Sheet 66S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

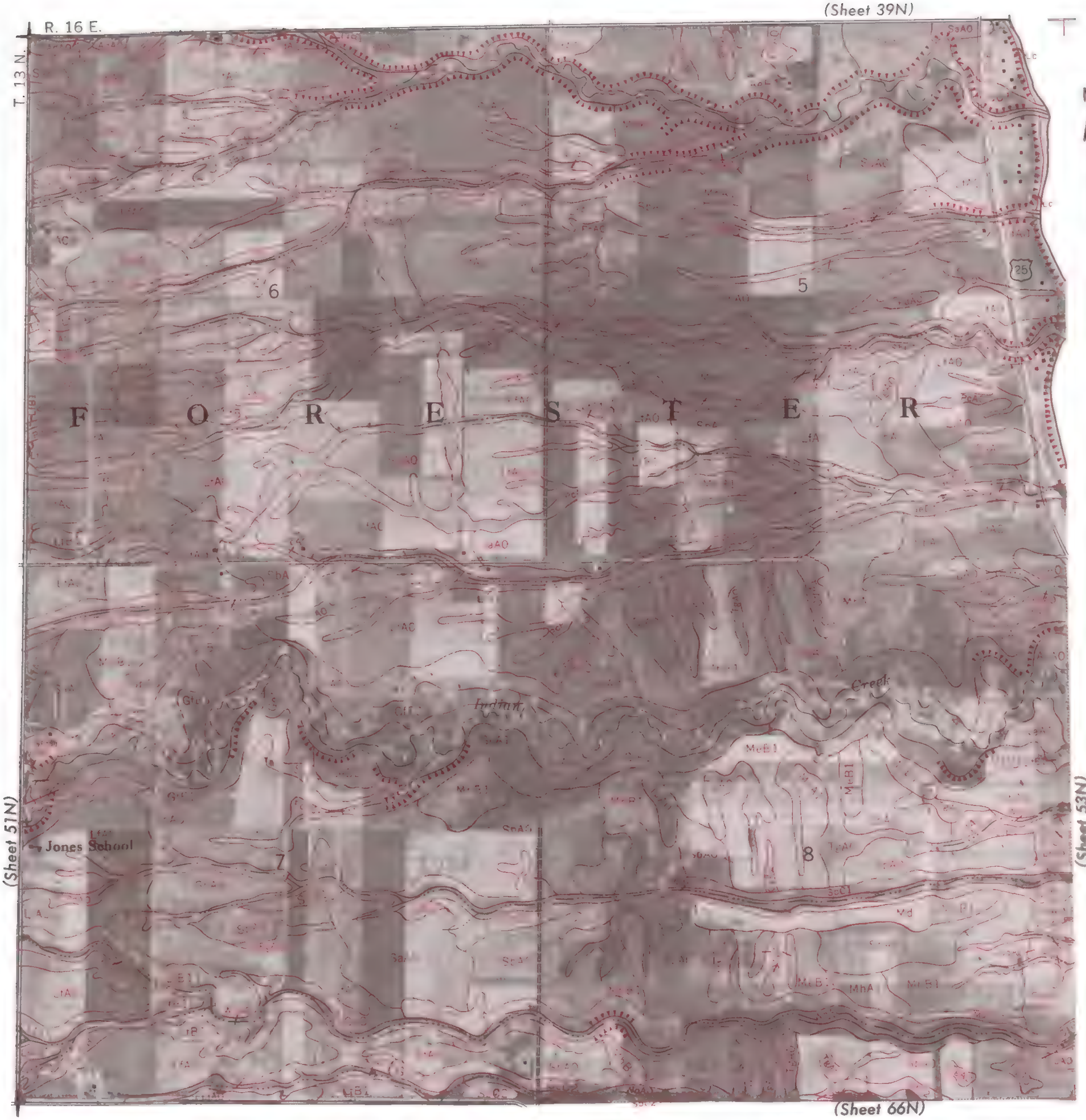
0 5000 Feet

SANILAC COUNTY, MICHIGAN

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet

53N

SANILAC COUNTY, MICHIGAN

R. 16 E.

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 — 1/2 — 1 Mile

0 — 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

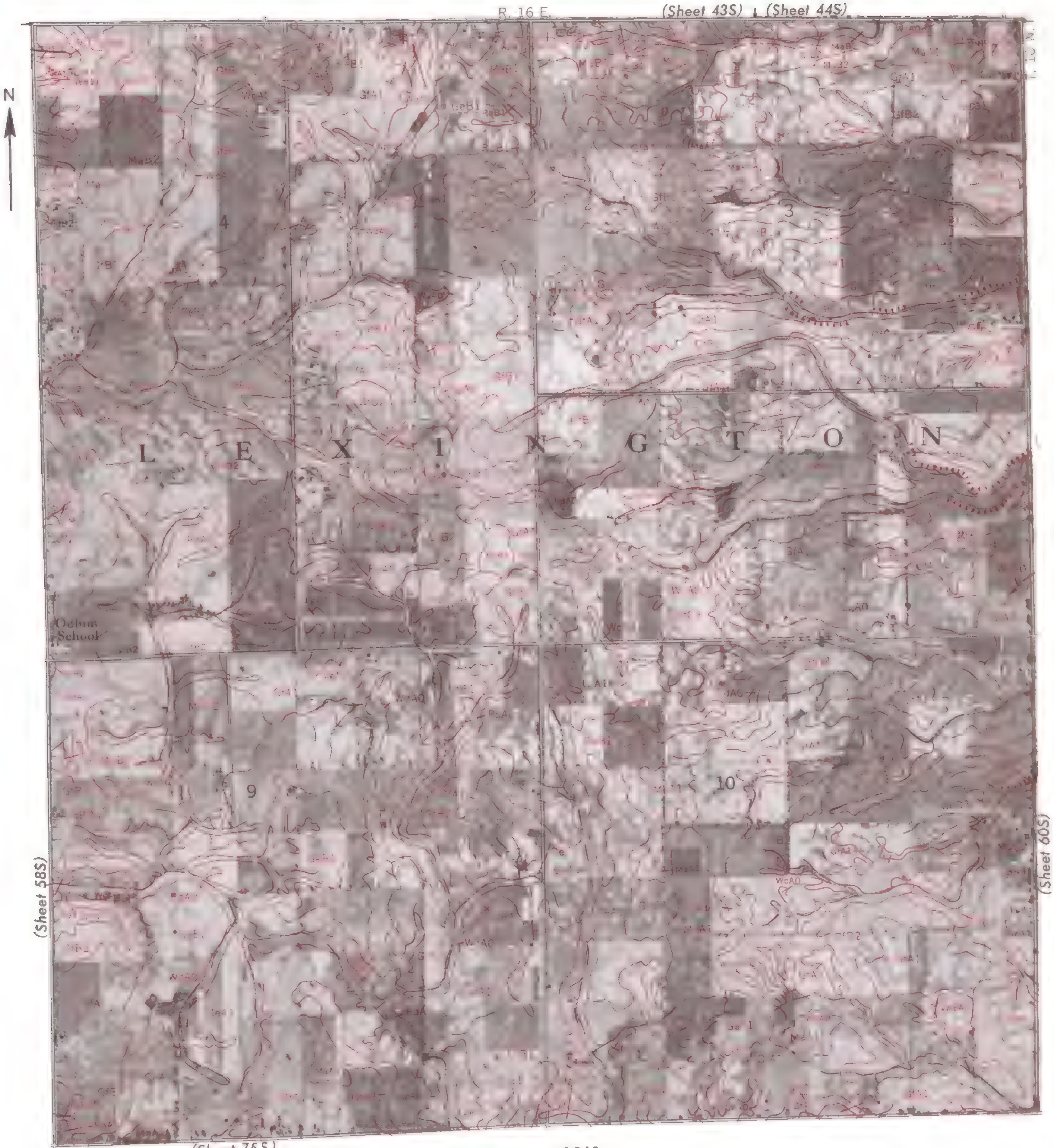
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

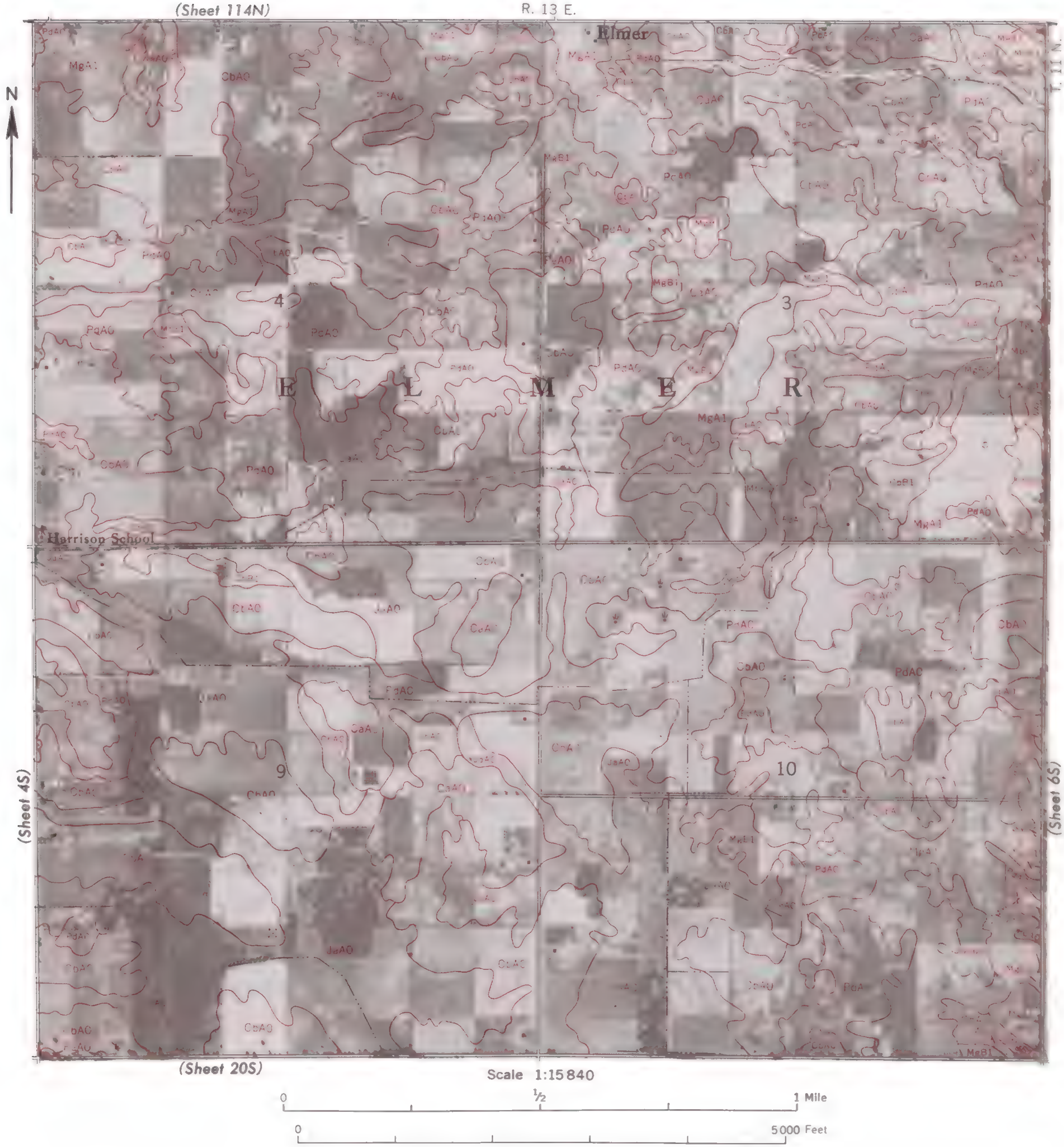


Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


HURON R. 13 E. COUNTY
T. 14 N.
N
Tyre
Drain
4
3
A U S T I N
Hogs Back
School
Peruski Drain
9
10
Tough Drain
South Fork Cass River
(Sheet 4N)
(Sheet 6N)
(Sheet 18N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


(Sheet 114N)
R. 13 E.
T. 11 N.
N
Elmer
Harrison School
E L M E R
4
3
9
10
(Sheet 4S)
(Sheet 6S)
(Sheet 20S)
Scale 1:15840
0
½
1 Mile
5000 Feet

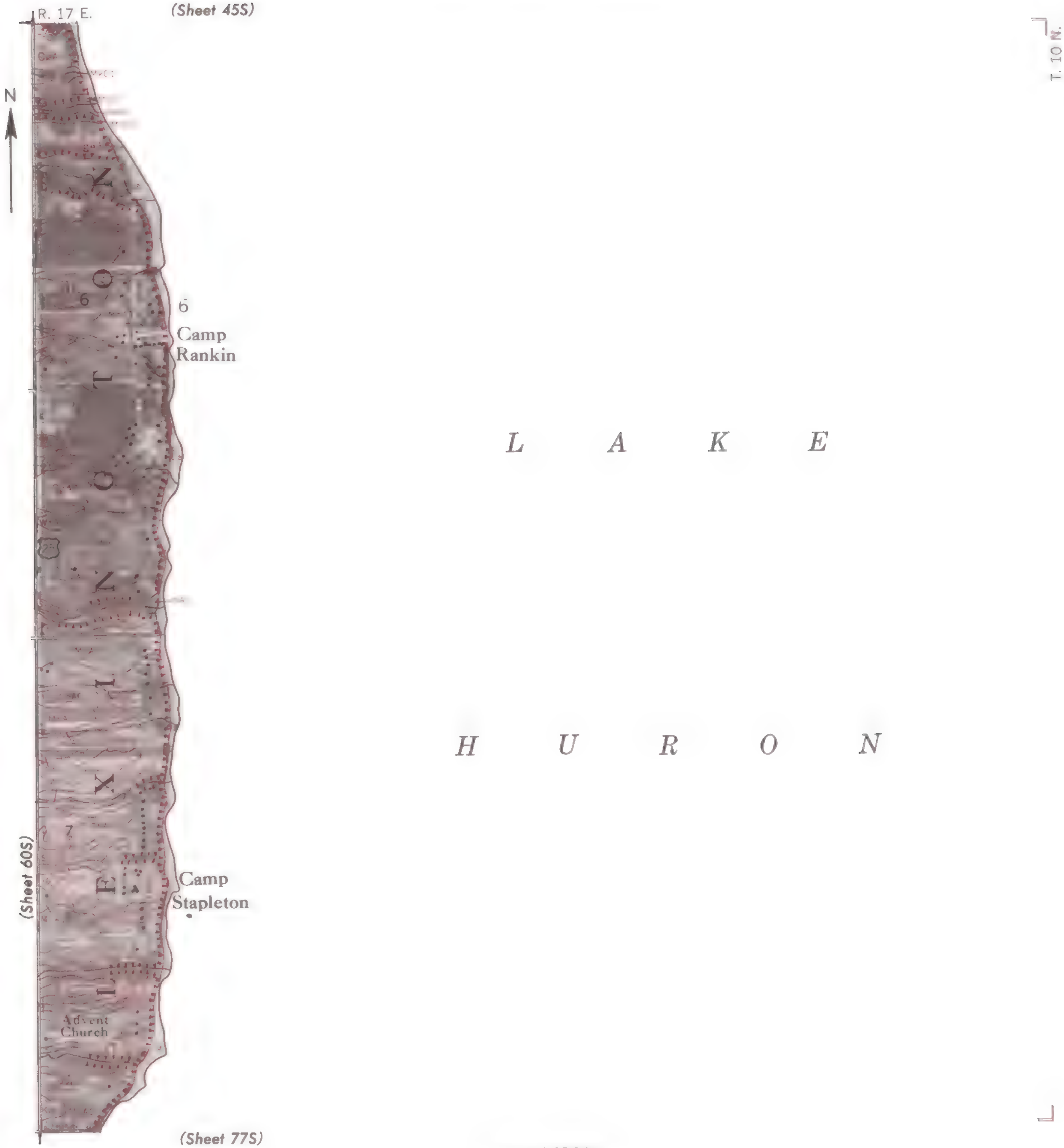

R. 14 E.
(Sheet 46N)
N
Ritchie
Drain
Drain
18
Palmer
School
17
Hewitt
Drain
Sutherland
W H E A T L A N D
T. 13 N.
Wheatland
Church
Ritchie Drain
19
20
(Sheet 59N)
(Sheet 61N)
Ritchie
Drain
(Sheet 74N)
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet


N
R. 14 E.
(Sheet 47N)
Marks School
Black River
16
15
W H E A T L A N D
T. 13 N.
Wheatland Town Hall
21
22
Drain
(Sheet 60N)
(Sheet 62N)
Caroll
Michel School
(Sheet 75N)
Scale 1:15840
0
½
1 Mile
0
5000 Feet



Scale 1:15 840

0 ½ 1 Mile

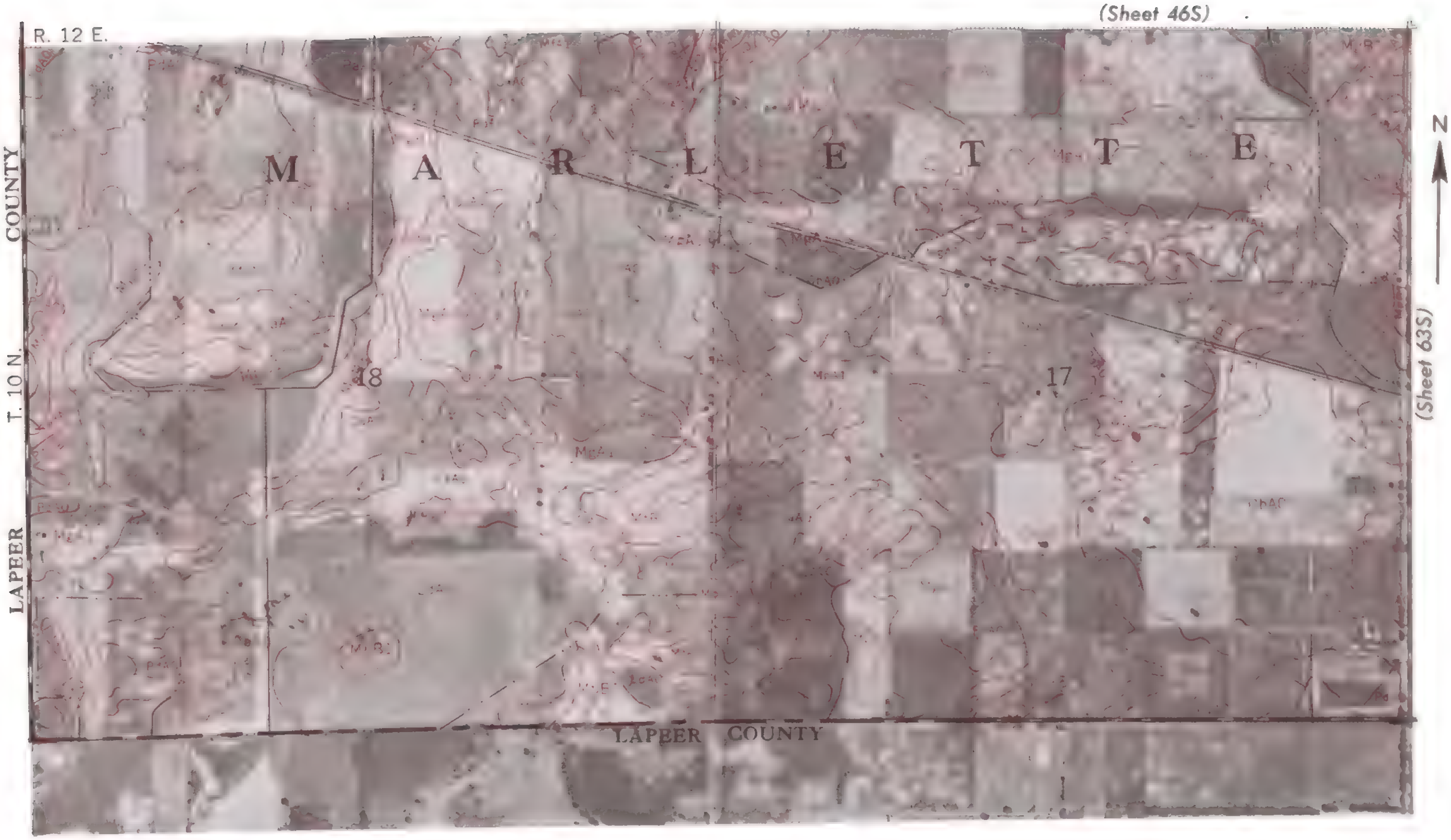
0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

(Sheet 46S)



(Sheet 63S)

Scale 1:15 840

0 ½ 1 Mile

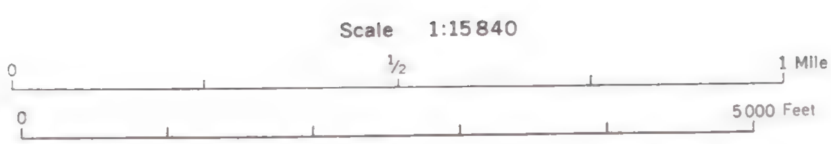
0 5000 Feet

Scale 1:15 840

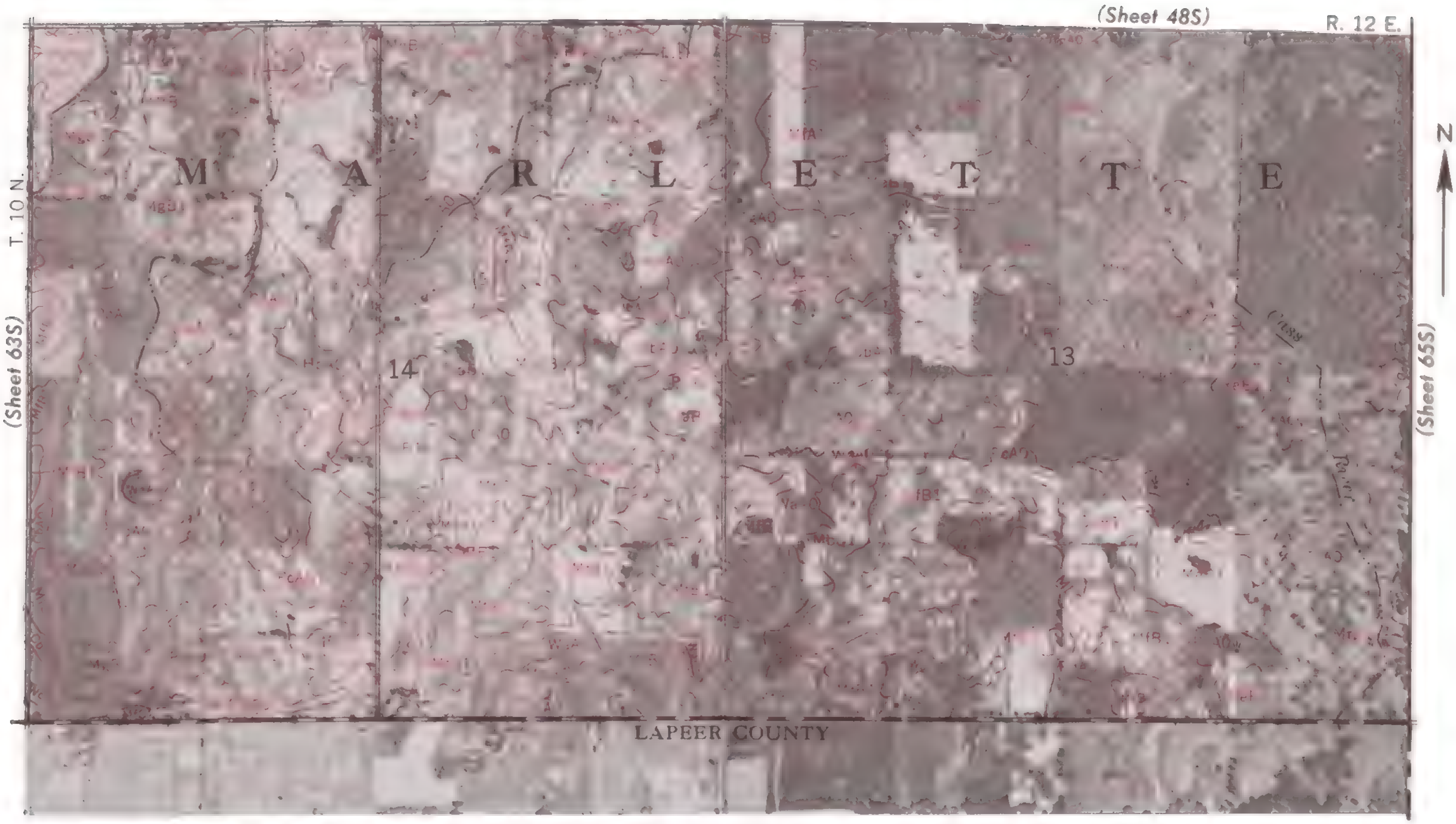
0 ½ 1 Mile

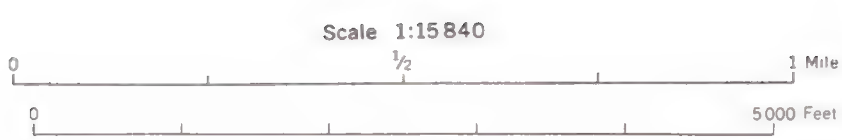
0 5000 Feet


(Sheet 47S)
R. 12 E.
N
(Sheet 62S)
(Sheet 64S)
T. 10 N.
CHESAPEAKE
AND
OHIO
16
15
M A R L E T T E
LAPEER COUNTY


Scale 1:15840
0
½
1 Mile
0
5000 Feet


R. 15 E.
(Sheet 50N)
T. 13 N.
(Sheet 63N)
(Sheet 65N)
(Sheet 78N)
N
16
15
21
22
M A R I O N
Parson Drain
Indian Creek
Big Creek
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


(Sheet 48S)
R. 12 E.
T. 10 N.
(Sheet 63S)
(Sheet 65S)
M A R L E T T E
14
13
N
LAPEER COUNTY


Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


R. 13 E.
(Sheet 50S)
N
16
15
F L Y N N
Flynn Town Hall
T. 10 N.
Drain
Settler
21
22
(Sheet 65S)
(Sheet 67S)
(Sheet 79S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 51S)
R. 13 E.
N
14
13
F L Y N N
Poplar Point School
T. 10 N.
23
24
(Sheet 66S)
(Sheet 68S)
(Sheet 80S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

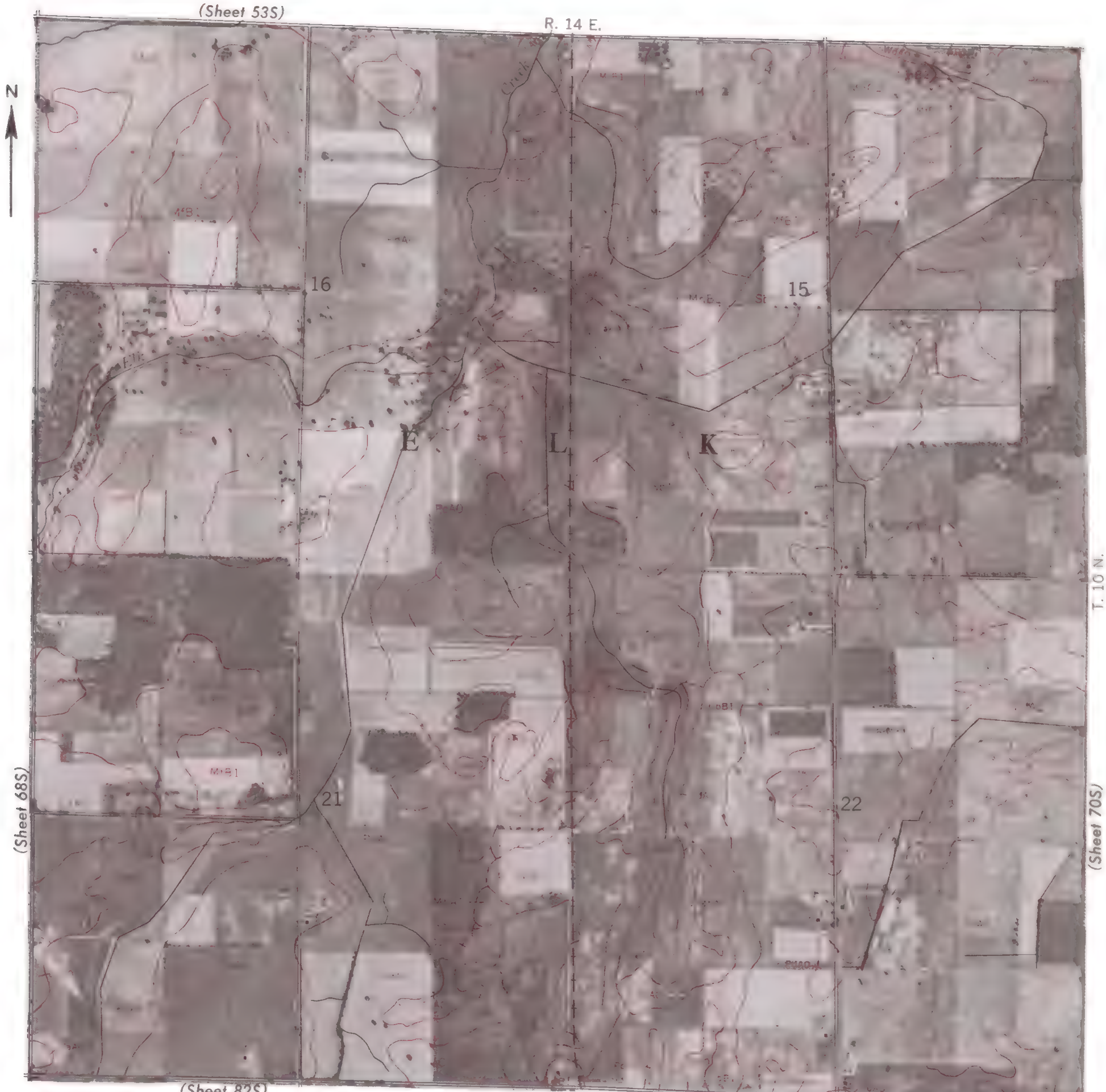
0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


(Sheet 55N)
R. 12 E.
N
28
27
CASS
E V E R G R E E N
RIVER
33
34
(Sheet 68N)
(Sheet 70N)
(Sheet 83N)
T. 13 N.
Scale 1:15840
0
½
1 Mile
0
5000 Feet



Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


HURON COUNTY
R. 13 E.
T. 14 N.
N
Tyre Drain
CHESAPEAKE AND OHIO
Tyre
Lamka Drain
2
1
A U S T I N
Cass River
Tyre School
11
12
South Fork
Austin Creek
(Sheet 5N)
(Sheet 7N)
(Sheet 19N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

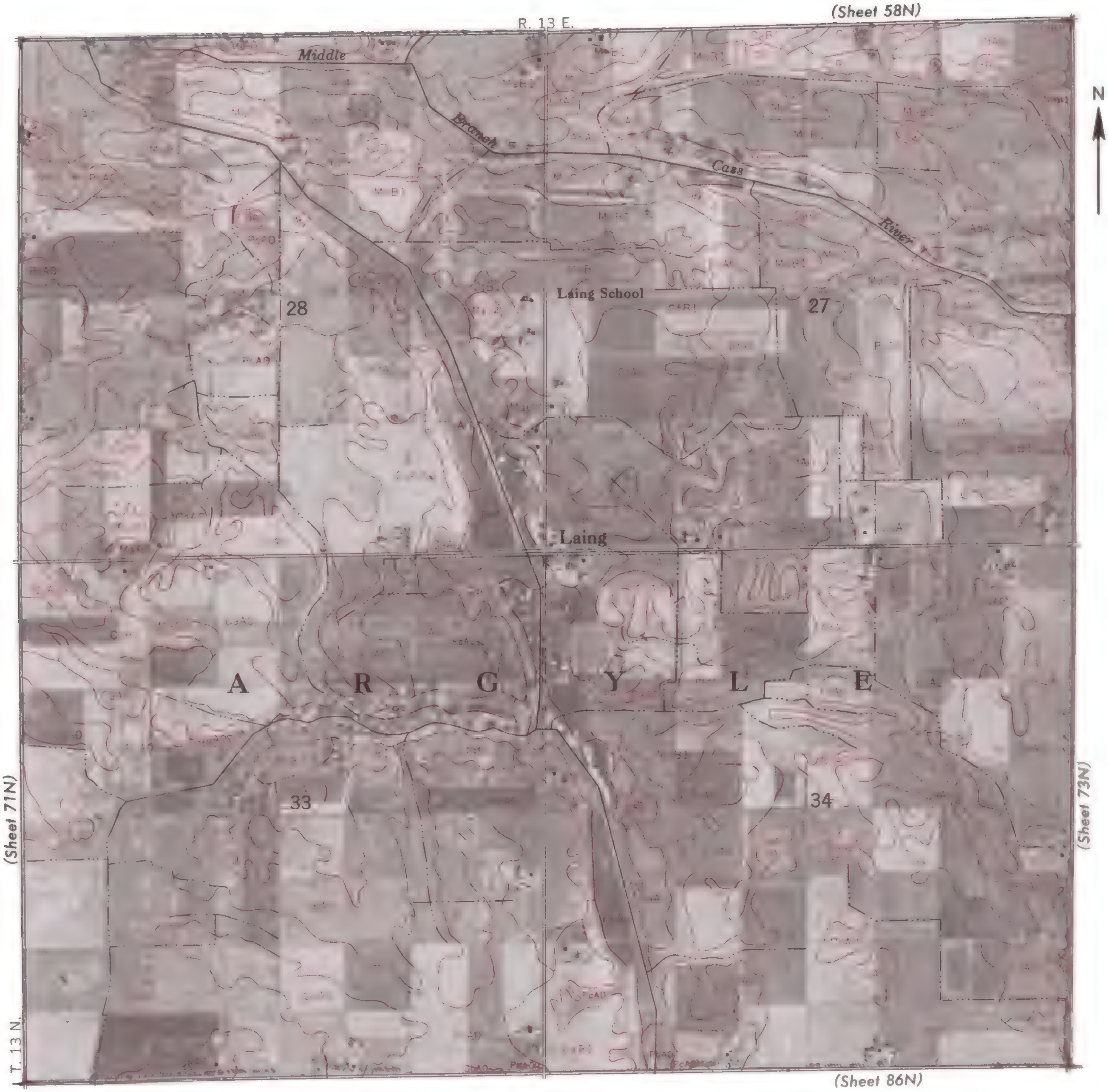

(Sheet 54S)
R. 14 E.
N
14
13
Creek
E
L
K
T. 10 N.
Spring
23
24
(Sheet 69 S)
(Sheet 71 S)
(Sheet 83 S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 13 E.
(Sheet 57N)
N
30
29
A R G Y L E
31
32
(Sheet 70N)
(Sheet 72N)
(Sheet 85N)
T. 13 N.
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet



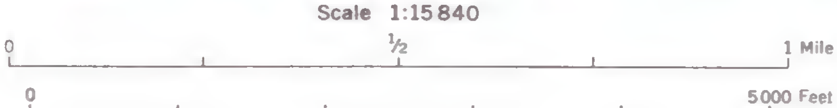
Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


R. 15 E.
(Sheet 56S)
N
Arnot
Creek
Creek
Buel Center
School
16
15
B
U
E
L
T. 10 N.
Buel Town Hall
(Sheet 71S)
French
21
22
(Sheet 73S)
(Sheet 85S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840




(Sheet 57S)
R. 15 E.
N
Arnot
Creek
14
13
B U E L
Baker School
T. 10 N.
23
24
(Sheet 72S)
(Sheet 74S)
(Sheet 86S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

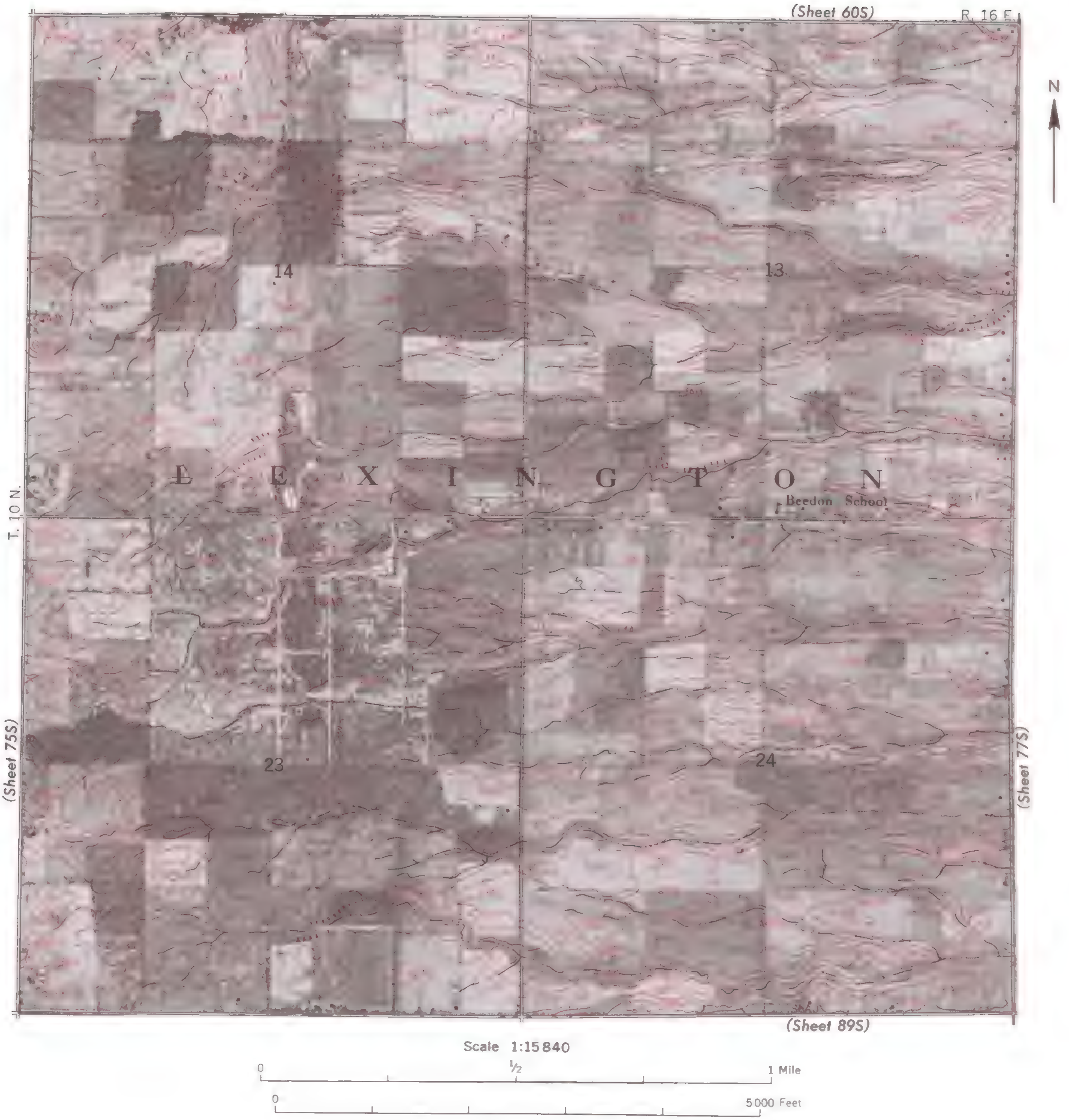
0 5 000 Feet


(Sheet 58S)
R. 16 E.
N
18
17
LEXINGTON
CHESAPEAKE AND OHIO
Arnot
Creek
BLACK
T. 10 N.
19
20
Kemp School
(Sheet 73S)
(Sheet 75S)
CROSWELL
(Sheet 87S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


(Sheet 61 N)
R. 14 E.
N
Drain
Ritchie
28
27
Thompson
Drain
W H E A T L A N D
Drain
33
Ritchie
34
(Sheet 74N)
(Sheet 76N)
T. 13 N.
(Sheet 89N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


R. 16 E.
(Sheet 59S)
N
County Farm
16
15
L E X I N G T O N
T. 10 N.
(Sheet 74S)
21
22
Mill
Creek
(Sheet 76S)
(Sheet 88S)
Scale 1:15840
0
½
1 Mile
0
5000 Feet


(Sheet 62N)
R. 14 E.
N
Drain
Thompson
26
25
BLACK
Pelton
Drain
Bufton School
W H E A T L A N D
Flannigan
Drain
RIVER
(Sheet 75N)
(Sheet 77N)
35
36
Ritchie
Drain
Downing
Cemetery
T. 13 N.
(Sheet 90N)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


(Sheet 60S)
R. 16 E.
N
14
13
LEXINGTON
Beedon School
T. 10 N.
(Sheet 75S)
23
24
(Sheet 77S)
(Sheet 89S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

R. 15 E.
(Sheet 63N)
N
Pelton
Drain
Pelton
Drain
30
29
M A R I O N
DECKERVILLE
Flannigan
Drain
31
32
CHESAPEAKE
(Sheet 76N)
(Sheet 78N)
Downington
T. 13 N.
(Sheet 91N)
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet


R. 17 E.
(Sheet 61S)
N
18
LEXINGTON
19
(Sheet 78S)
(Sheet 90S)
LAKE
HURON
T. 10 N.
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet


R. 13 E.
(Sheet 65S)
N
30
29
F L Y N N
South Muck
School
LAPEER COUNTY
Settler Drain
31
32
(Sheet 79S)
T. 10 N.
(Sheet 91S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5 000 Feet

SANILAC COUNTY, MICHIGAN

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

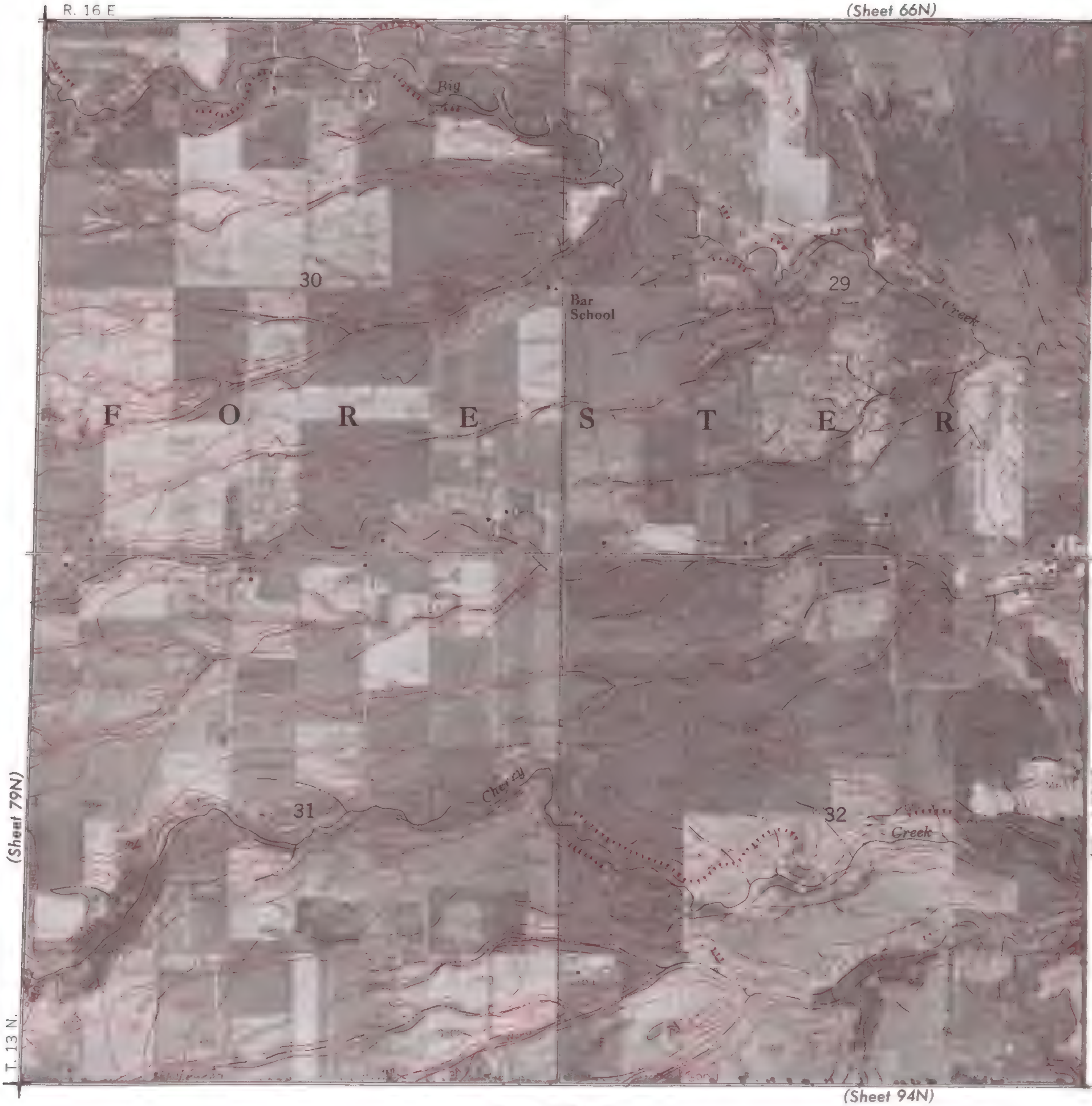
SANILAC COUNTY, MICHIGAN

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet


R. 14 E.
(Sheet 116N)
T. 11 N.
N
SANDUSKY
WATERTOWN
6
5
7
8
Gleason School
(Sheet 6S)
(Sheet 8S)
(Sheet 22S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

(Sheet 67N)

R. 16 E.

(Sheet 80N)

T. 13 N.

(Sheet 95N)

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 68N)
T. 12 N.
White
Creek
L A M O T T E
6
5
7
8
Moshier School
TUSCOLA COUNTY
(Sheet 83N)
(Sheet 96N)
N
Scale 1:15 840
1/2
1 Mile
0
5 000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 70N)
R. 12 E.
T. 12 N.
N
Cass
River
1
2
11
12
L A M O T T E
Foster School
(Sheet 83N)
(Sheet 85N)
(Sheet 98N)
Scale 1:15840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

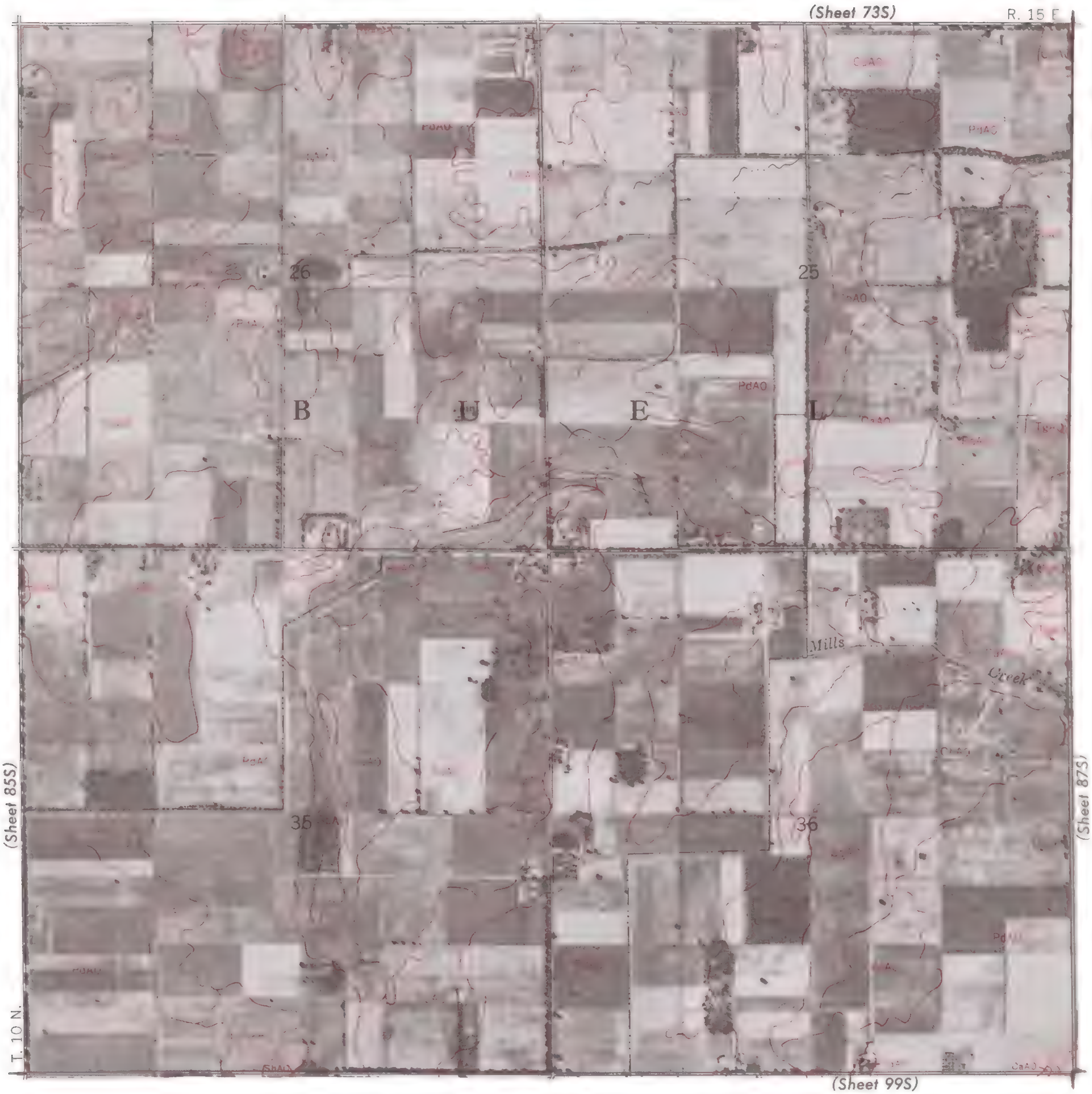
0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15 840
0 ½ 1 Mile
0 5000 Feet


(Sheet 73N)
R. 13 E.
T. 12 N.
N
Middle Branch Cass River
Brice Creek
2
1
11
12
M O O R E
(Sheet 86N)
(Sheet 88N)
(Sheet 101N)
Scale 1:15 840
0
½
1 Mile
0
5 000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


(Sheet 74N)
R. 14 E.
T. 12 N.
N
6
5
C U S T E R
Lee
School
7
8
(Sheet 87N)
(Sheet 89N)
(Sheet 102N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 16 E.
(Sheet 75S)
N
28
27
L E X I N G T O N
Mill
Huckins School
33
34
Creek
(Sheet 87S)
(Sheet 89S)
T. 10 N.
(Sheet 101S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet


(Sheet 75N)
R. 14 E.
T. 12 N.
N
4
3
C U S T E R
9
10
(Sheet 88N)
(Sheet 90N)
Custer Church
(Sheet 103N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


HURON R. 14 E. COUNTY
T. 14 N.
N
4
3
M I N D E N
Minden School
Dist. 3
9
10
Loyd Creek
(Sheet 7N)
(Sheet 9N)
(Sheet 21N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


R. 14 E.
(Sheet 117N)
T. 11 N.
N
SANDUSKY
4
3
W A T E R T O W N
Smaldon
Drain
9
10
(Sheet 7S)
(Sheet 9S)
(Sheet 23S)
Scale 1:15 840
0
½
1 Mile
0
5 000 Feet


(Sheet 76N)
R. 14 E.
T. 12 N.
N
1
Byette
Creek
2
BLACK
C U S T E R
Drain
Nicol
11
Doane School
12
RIVER
(Sheet 89N)
(Sheet 91N)
(Sheet 104N)
Scale 1:15840
0
½
1 Mile
0
5000 Feet


R. 17 E.
(Sheet 77S)
N
LAKE
HURON
30
LEXINGTON
31
(Sheet 89S)
T. 10 N.
(Sheet 103S)
Scale 1:15 840
0
1/2
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

R. 13 E.
(Sheet 78S)
T. 9 N.
N
MAPLE VALLEY
LAPEER COUNTY
CHESAPEAKE AND OHIO
BROWN CITY
West
Creek
(Sheet 92S)
(Sheet 104S)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

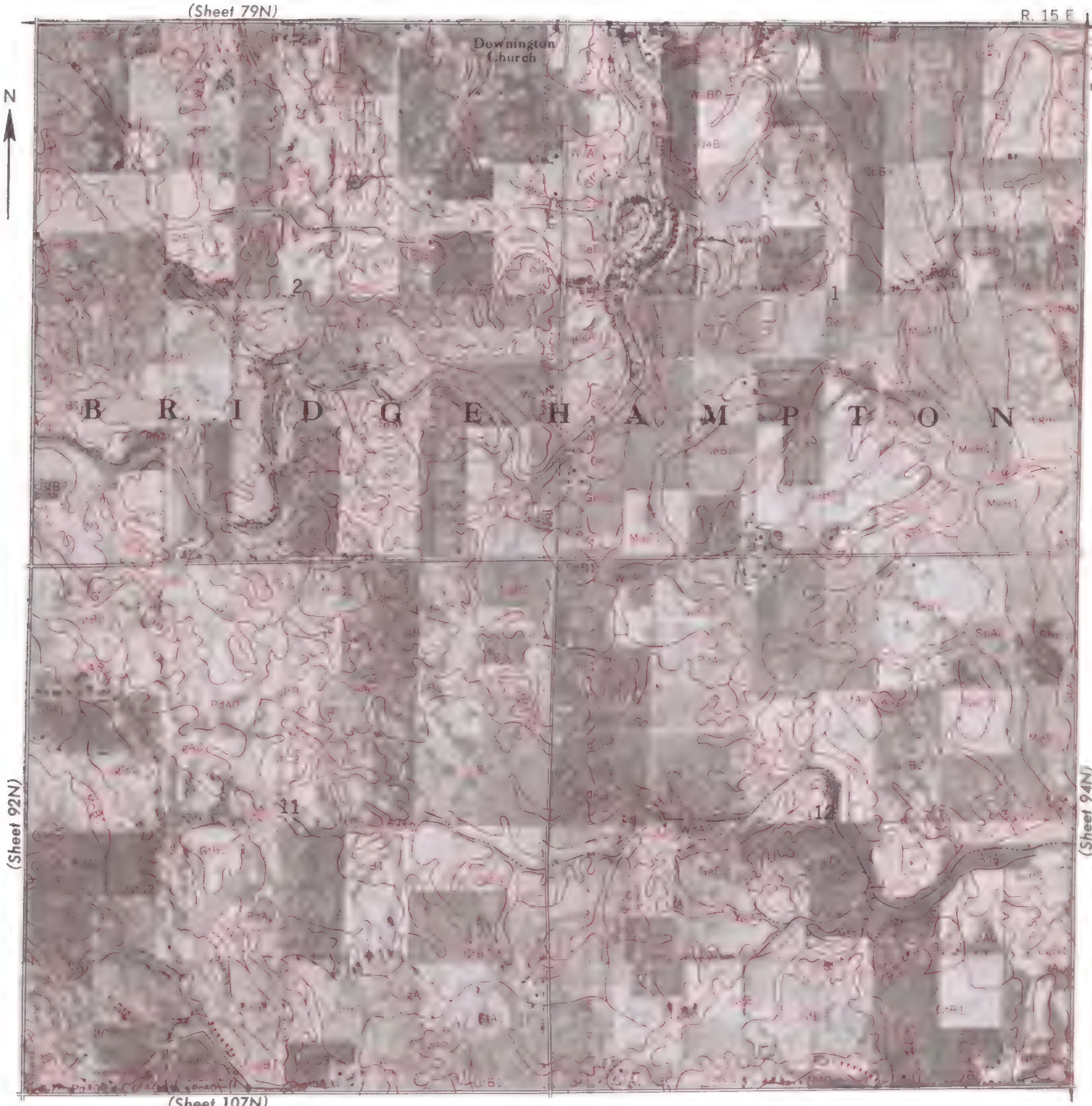

R. 15 E.
(Sheet 78N)
T. 12 N.
N
Cherry Creek
4
3
B R I D G E H A M P T O N
9
10
(Sheet 91N)
(Sheet 93N)
Bridgehampton River
(Sheet 106N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

SANILAC COUNTY, MICHIGAN



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

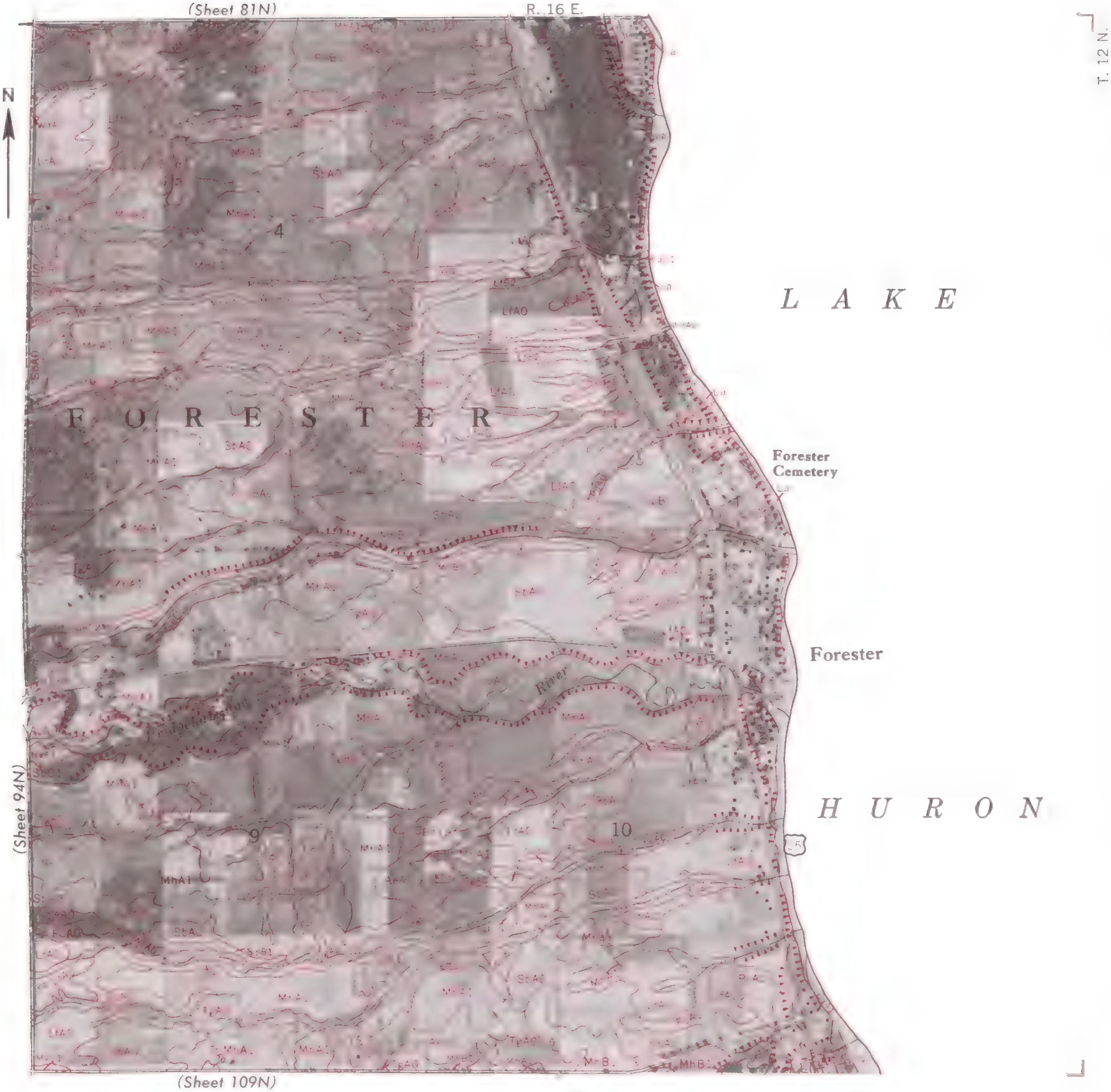
0 ½ 1 Mile

0 5 000 Feet

Scale 1:15840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

(Sheet 82S)

(Sheet 108S)

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet


R. 12 E.
(Sheet 82N)
N
18
17
Hemans
TUSCOLA T. 12 N. COUNTY
L A M O T T E
19
20
White
(Sheet 97N)
(Sheet 110N)
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


(Sheet 83S)
R. 14 E.
T. 9 N.
N
Teniswood School
Creek
S P E A K E R
2
1
11
12
Potts
(Sheet 95S)
(Sheet 97S)
(Sheet 109S)
PdAO
MtB1
CaB1
PdAO
Scale 1:15840
0
½
1 Mile
0
5000 Feet

Scale 1:15 840

0 ½ 1 Mile

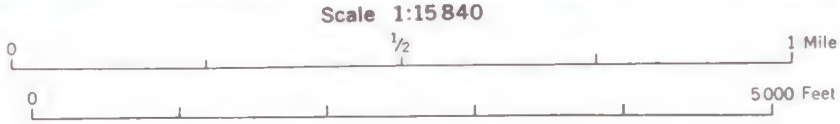
0 5000 Feet

Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

Scale 1:15 840

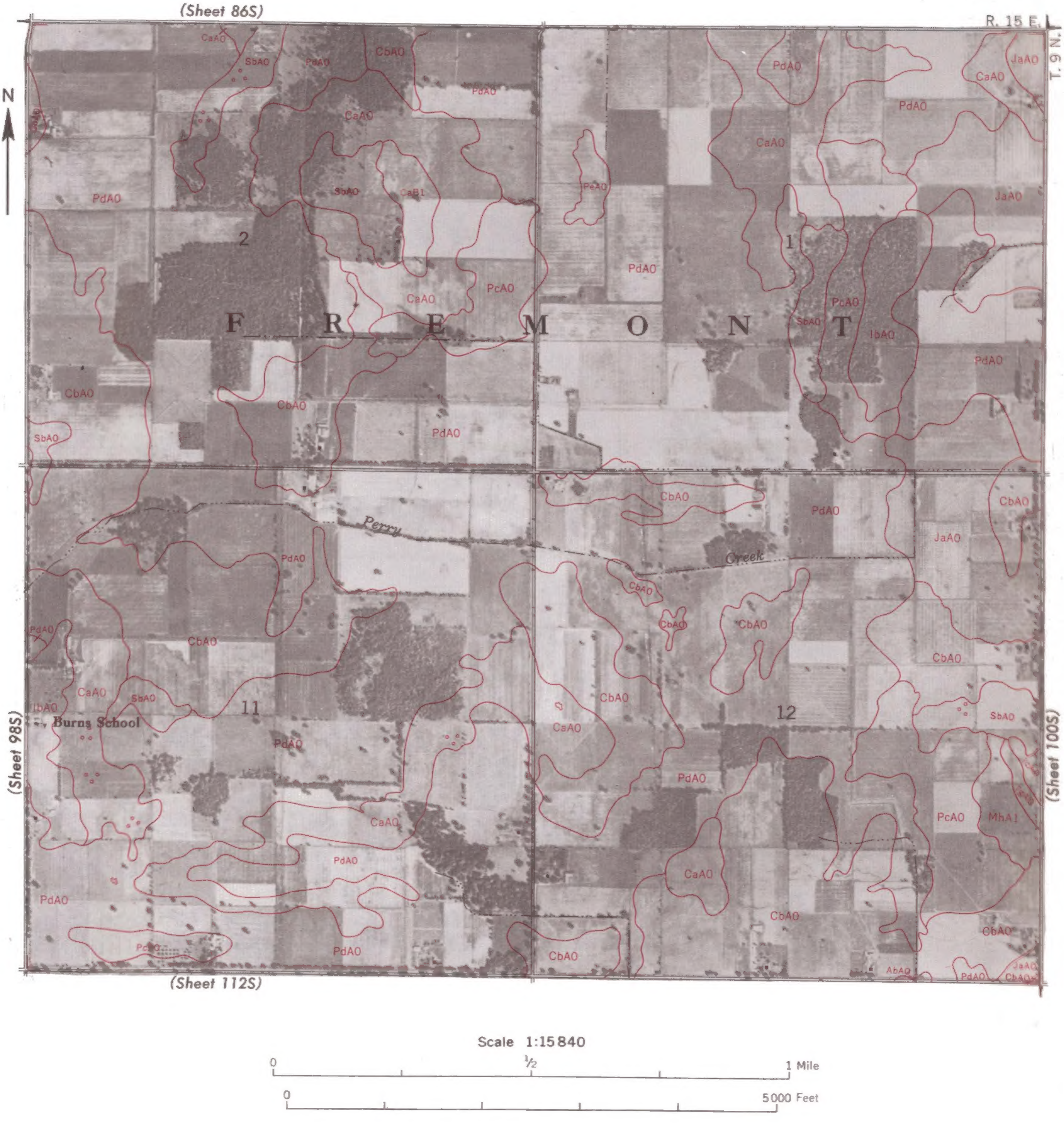


Scale 1:15 840

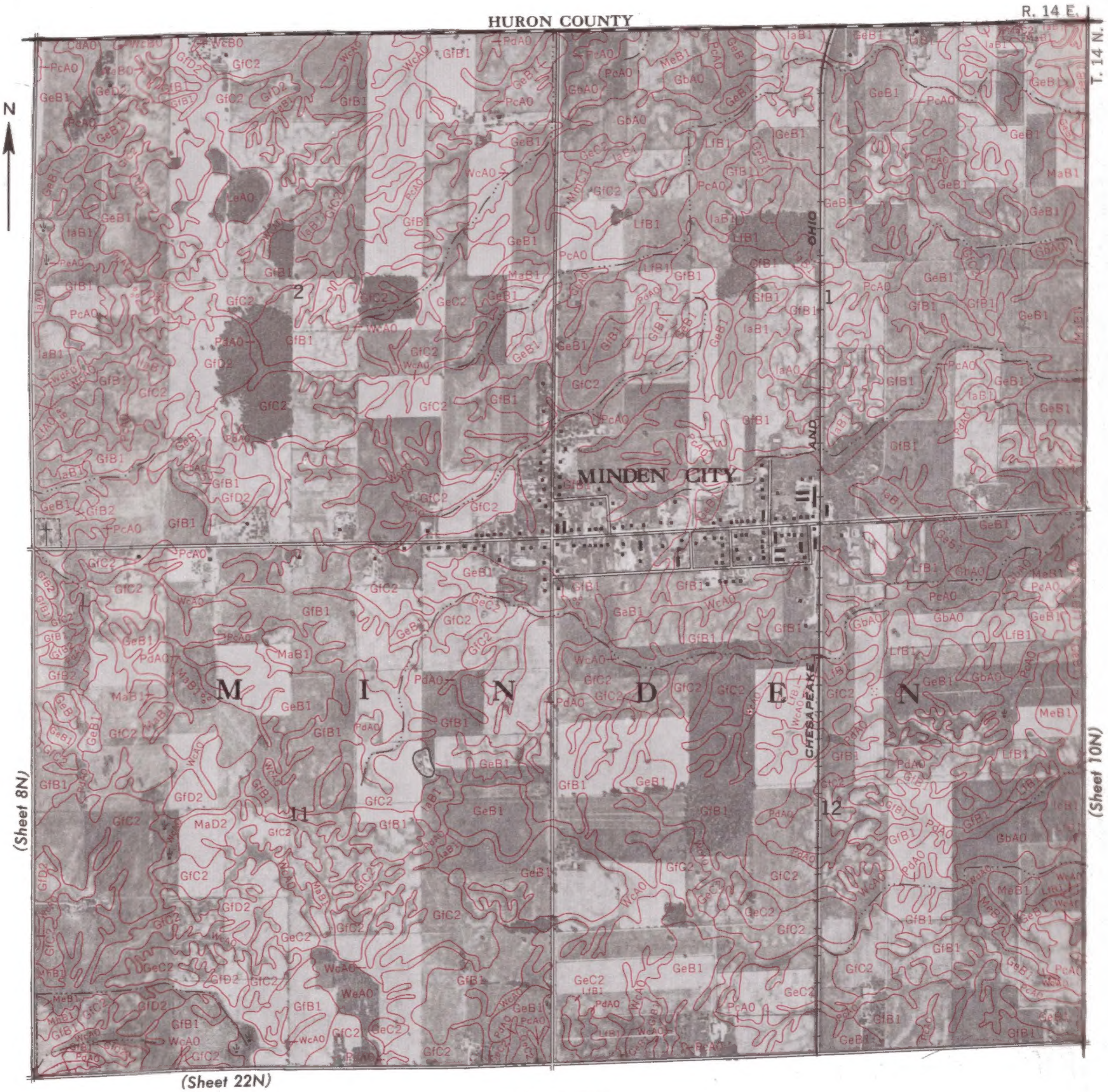
0 ½ 1 Mile

0 5000 Feet


R. 13 E.
(Sheet 85N)
N
18
17
19
20
M O O R E
Snover
T. 12 N.
(Sheet 98N)
(Sheet 100N)
(Sheet 113N)
River
Scale 1:15 840
0
½
1 Mile
0
5000 Feet


(Sheet 86S)
R. 15 E.
T. 9 N.
N
F R E M O N T
2
1
11
12
Perry
Creek
Burns School
(Sheet 98S)
(Sheet 100S)
(Sheet 112S)
CaAO
SbAO
PdAO
CbAO
CaB1
PcAO
IbAO
JaAO
MhA1
AbAO
Scale 1:15 840
0
½
1 Mile
0
5000 Feet

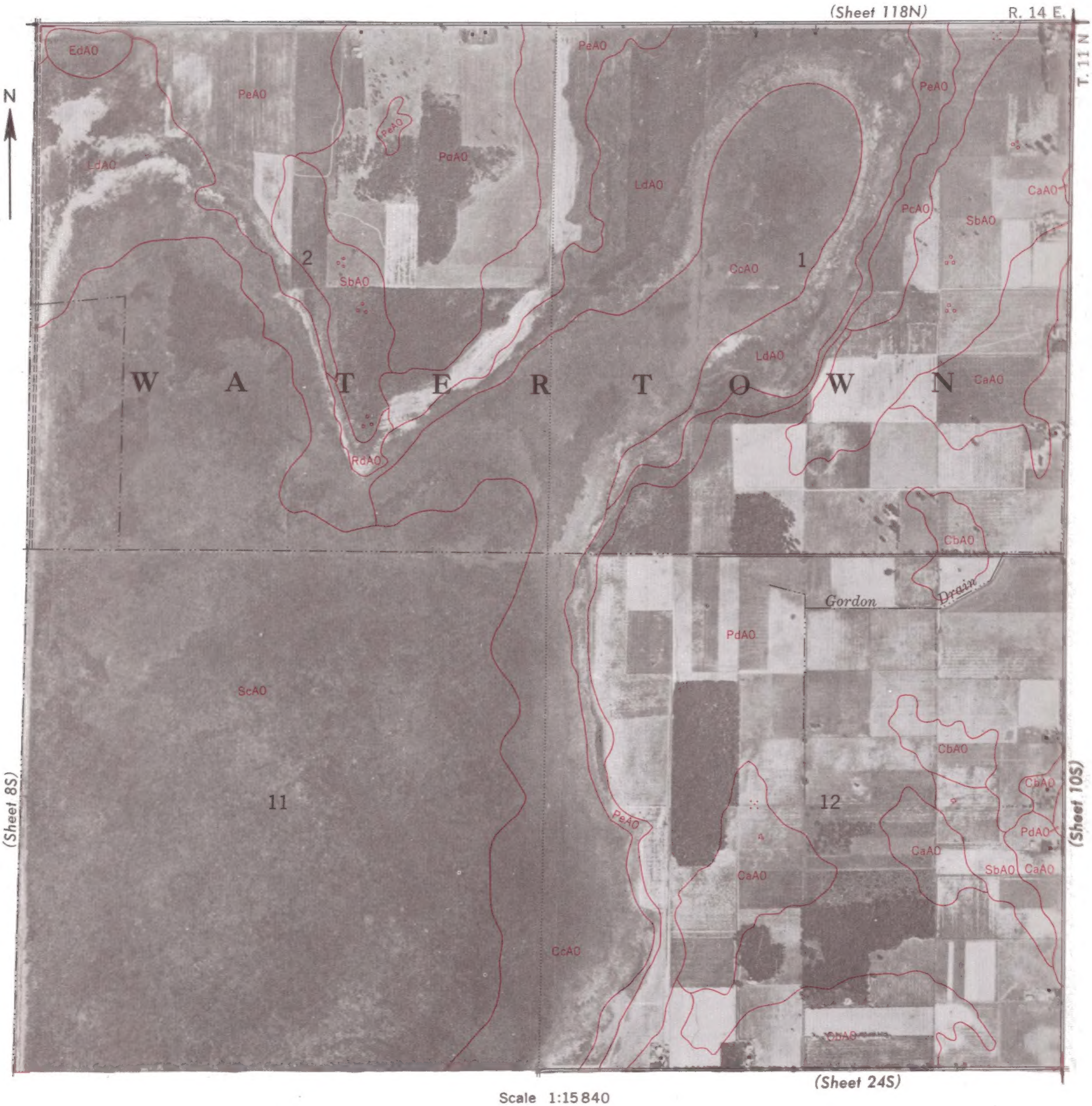
SANILAC COUNTY, MICHIGAN



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet



Scale 1:15 840

0 ½ 1 Mile

0 5000 Feet

SANILAC COUNTY, MICHIGAN

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Roads
- Good motor
- Poor motor
- Trail
- Marker, U. S. 33

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferry
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mine and Quarry
- Dump

Pits, gravel or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Oil wells

BOUNDARIES

- National or state
- County
- Township, civil
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL, DITCH

Intermittent ditch

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing

Springs

Marsh

Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil type outline and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Kitchen midden
- Blowout
- Gullies